

# THE ANTENNA LABORATORY

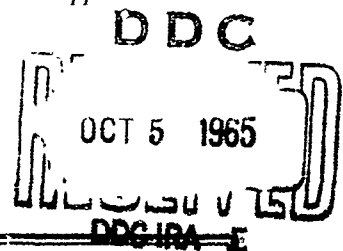
RESEARCH ACTIVITIES in ---

*Automatic Controls    Antennas    Echo Area Studies*  
*Microwave Circuits    Astronautics    E M Field Theory*  
*Terrain Investigations    Radomes    Systems Analysis*  
*Wave Propagation    Submillimeter Applications*

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Pattern Handbook  
Volume VI: Far-Field Patterns of a Linear  
Antenna Radiating in the Presence  
of Circular Cylinders

C. H. Brenner

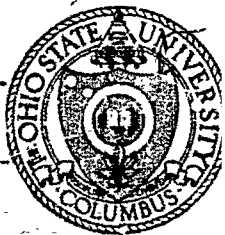
Contract No. N123(953) -31663A

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1 August 1965

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Code 3300b  
San Diego, California

Department of ELECTRICAL ENGINEERING



THE OHIO STATE UNIVERSITY  
RESEARCH FOUNDATION  
Columbus, Ohio

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REPORT 1522-16

REPORT  
by  
THE OHIO STATE UNIVERSITY RESEARCH FOUNDATION  
COLUMBUS, OHIO 43212

Sponsor	U. S. Navy Electronics Laboratory Code 3300b San Diego, California
Contract No.	N123(953)31663A
Investigation of	Study Program Related to Shipboard Antenna System Environment
Subject of Report	Pattern Handbook Volume VI: Far-Field Patterns of a Linear Antenna Radiating in the Presence of Circular Cylinders
Submitted by	C.H. Brenner Antenna Laboratory Department of Electrical Engineering
Date	1 August 1965

## PREFACE

The prediction of fields radiated by shipboard antennas is complicated by the presence of parasitically excited superstructure which warps and deteriorates the far-field patterns. If antennas are to be located in some logical manner on the ship, or if the ship design itself is to take account of the primary radiating elements, then some guides must be found to account for the influence of superstructure on antenna patterns. To this end, a handbook has been compiled, giving patterns of a thin, linear, vertical antenna radiating in the presence of cylindrical conducting structures of various cross-sectional shape. The model used to approximate this configuration is that of an infinite line source, representing the dipole, radiating in the presence of an array of thin, infinite wires parallel to each other and outlining the surface of the offending cylindrical structure. It has been shown [1] that such a wire approximation is electrically similar to the solid metallic surface if at least 5 wires per wavelength of perimeter are used. It has also been shown [2] that the patterns obtained from the infinitely tall model in the plane normal to the cylinder axis are good approximations to those obtained from the actual finite height configuration so long as the offending structure is taller than the source antenna, preferably twice as tall [3].

Because long distance communication systems aboard ship usually operate at wavelengths between 10 and 100 meters, structures which have rather sizeable physical dimensions are not very large in terms of wavelength. For this reason, only offending structures up to 2 wavelengths on a side are considered. It has been found from sample calculations that patterns for objects larger than 2 wavelengths on a side do not differ radically from those for the largest objects presented in this handbook.

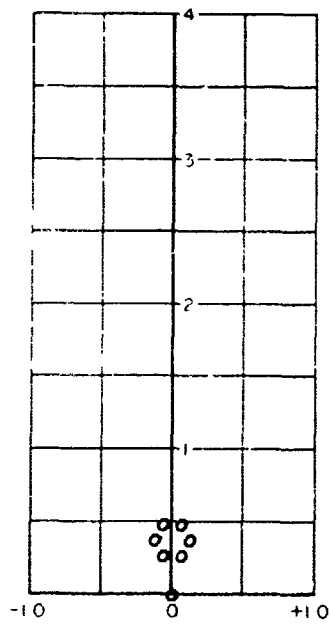
The computer program used to calculate the patterns in this handbook is an automated version of the SCATTRAN program described in Reference 2. Certain innovations were incorporated to improve efficiency of operation.

## ACKNOWLEDGEMENT

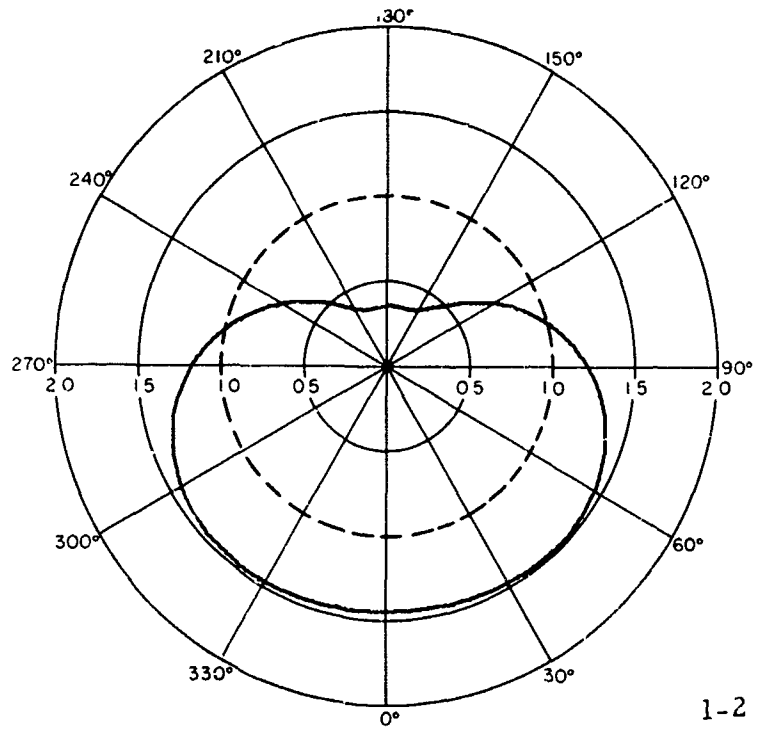
The author wishes to acknowledge the assistance of Mr. G. A. Thiele in modifying the computer program and in preparing this handbook.

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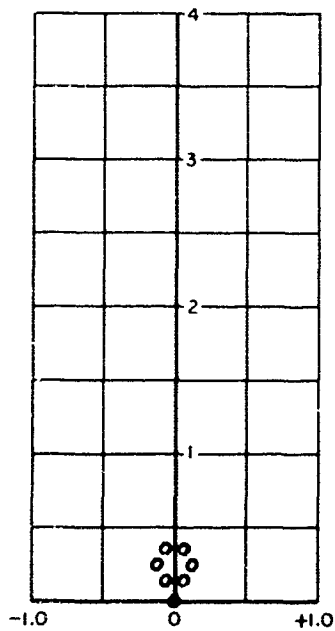
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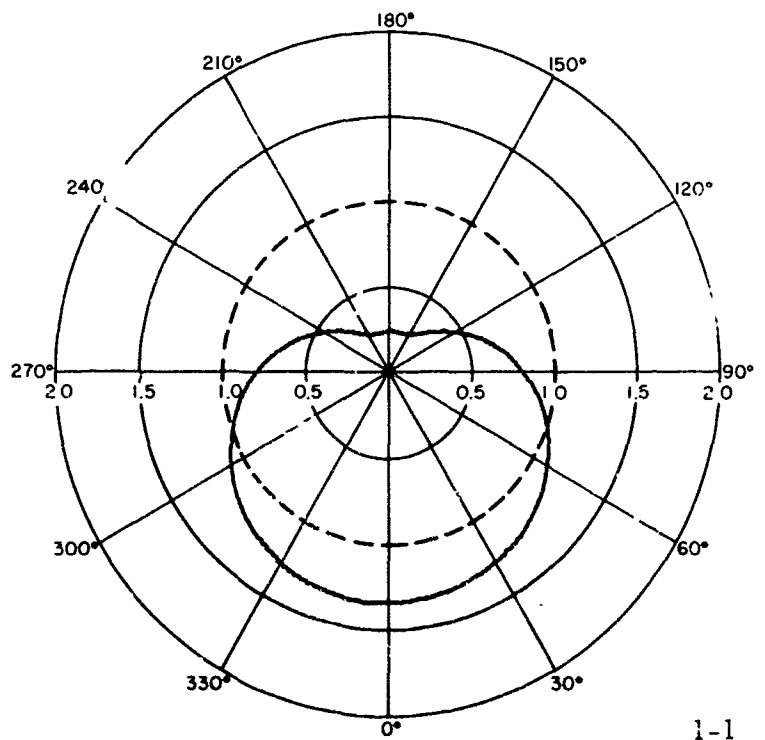
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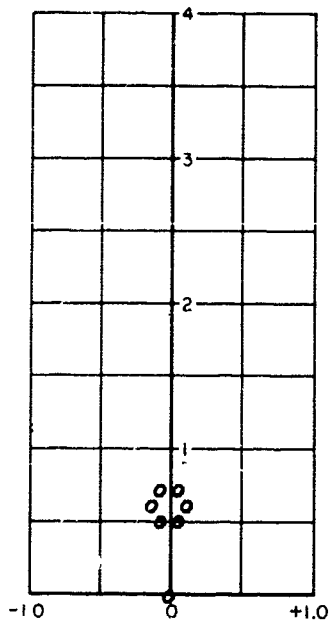
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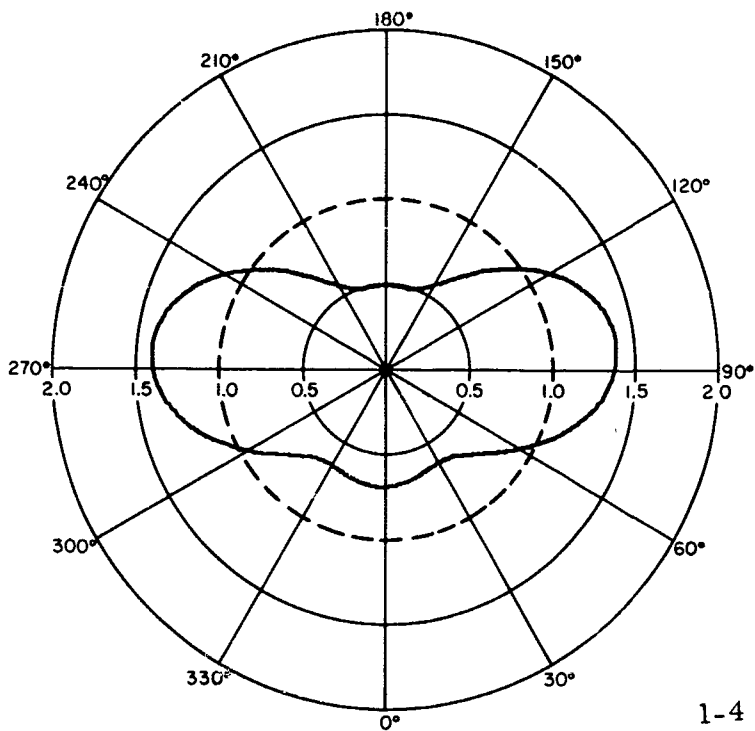
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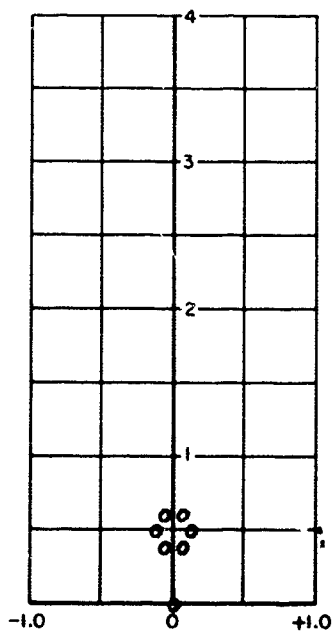
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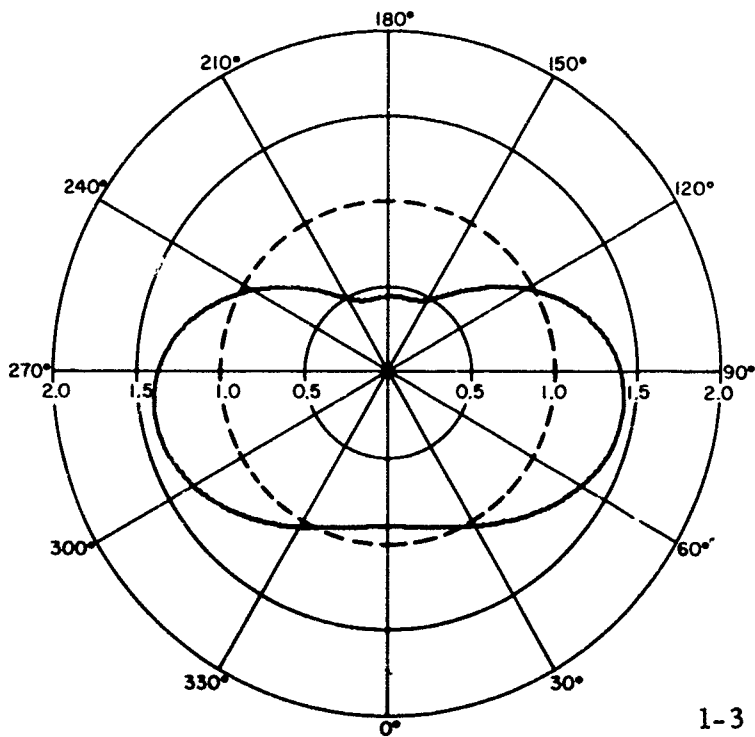
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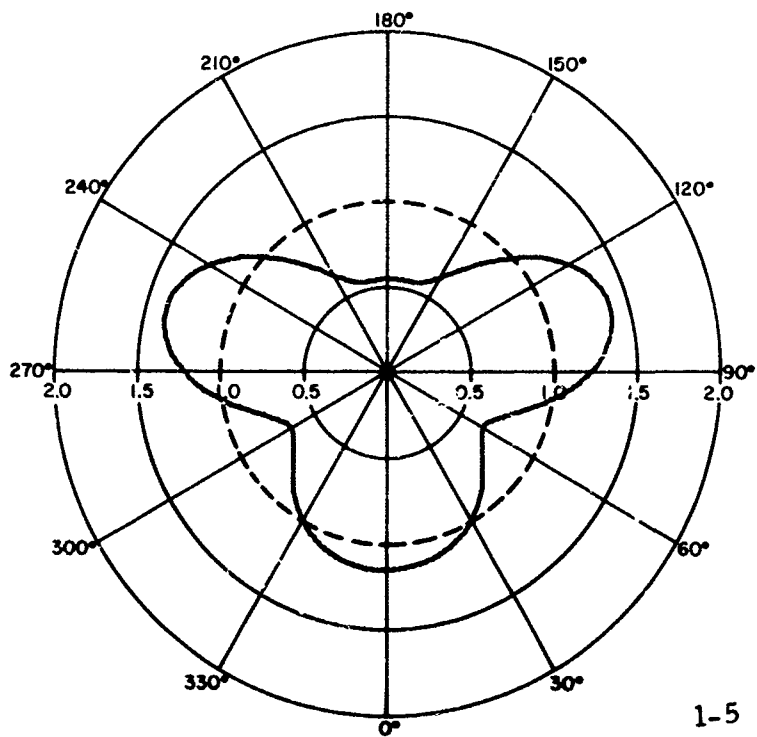
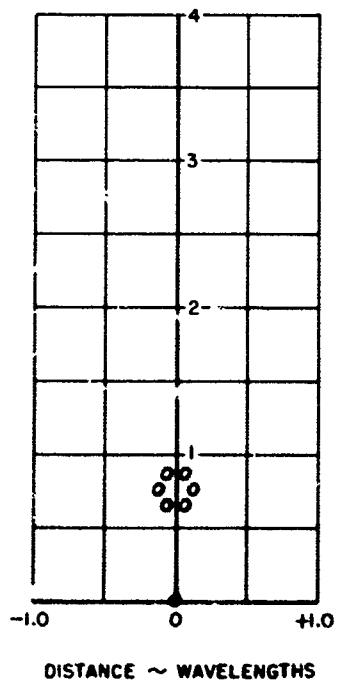
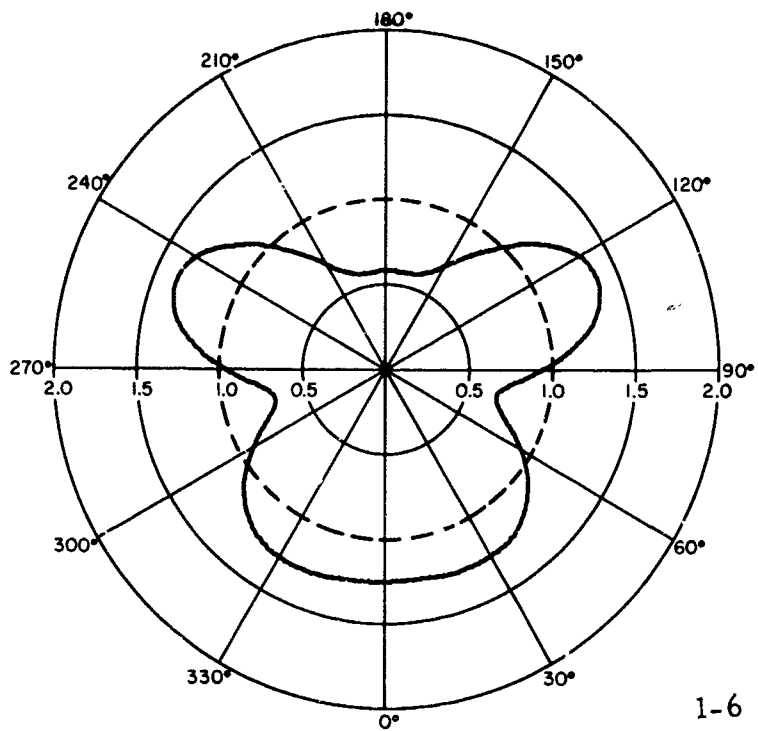
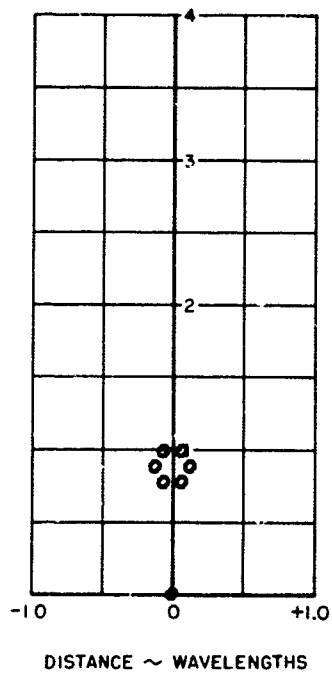
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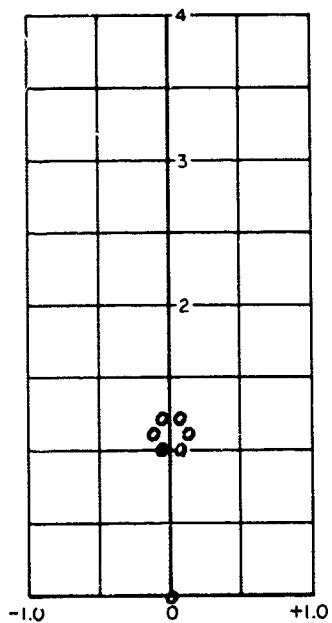
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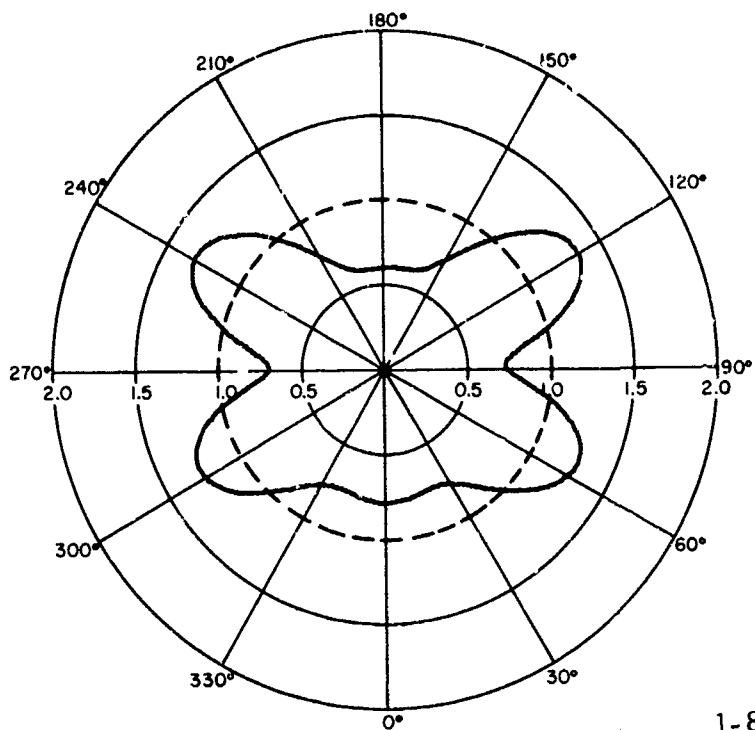
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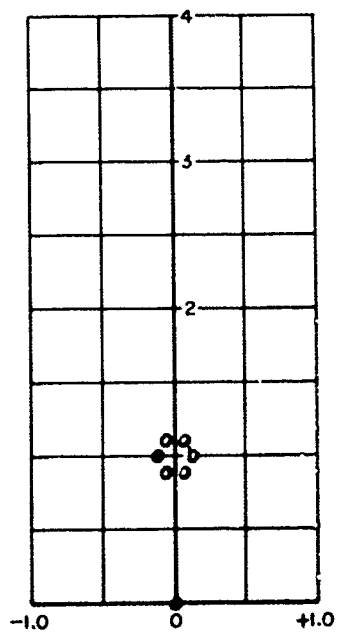




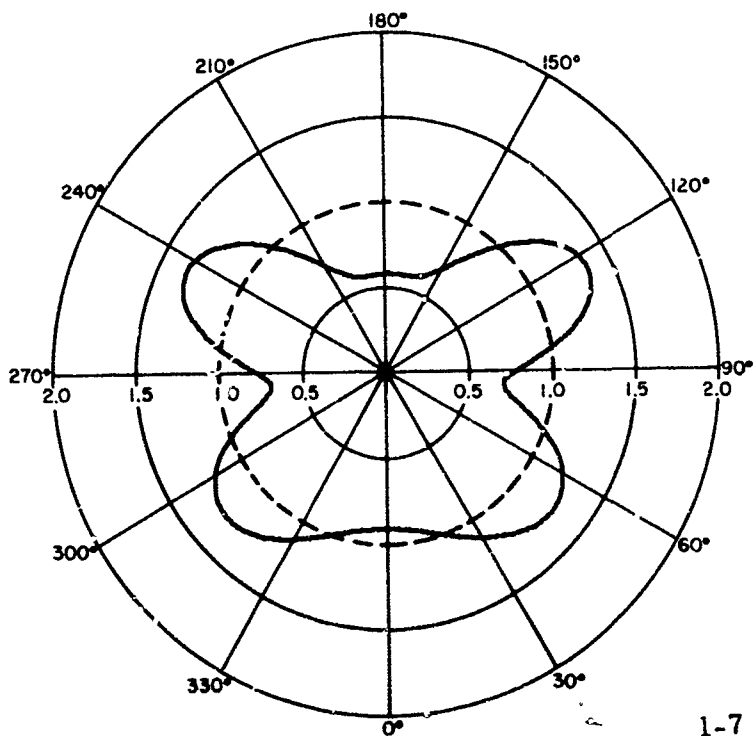
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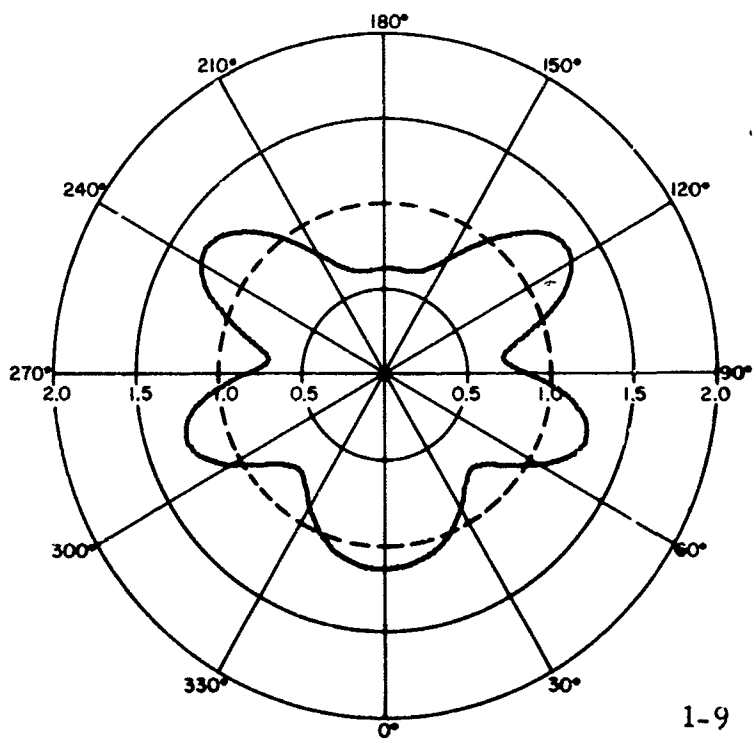
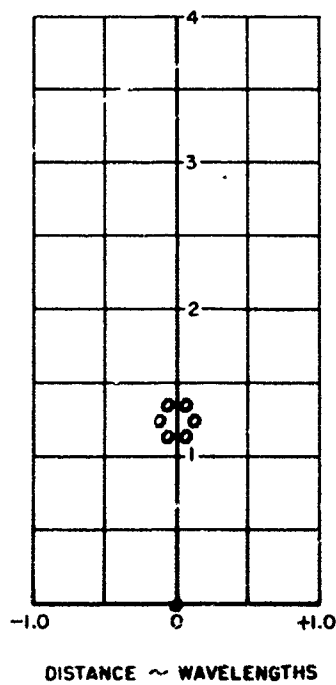
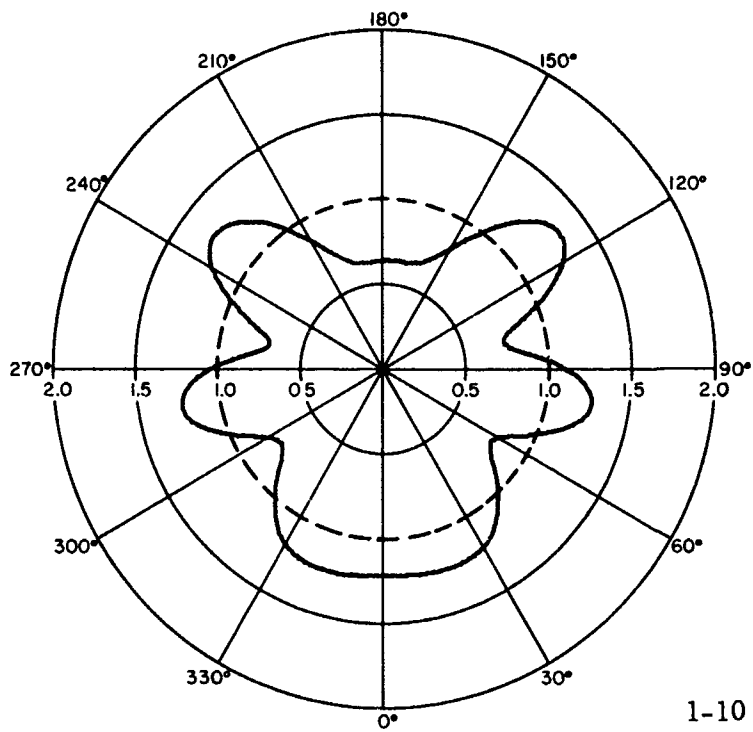
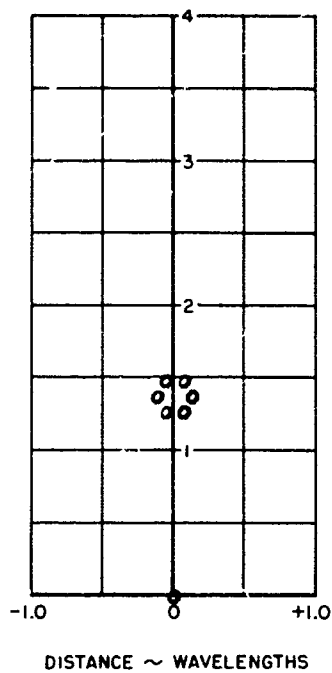
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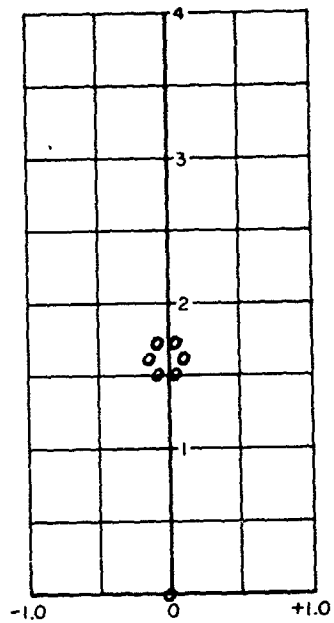


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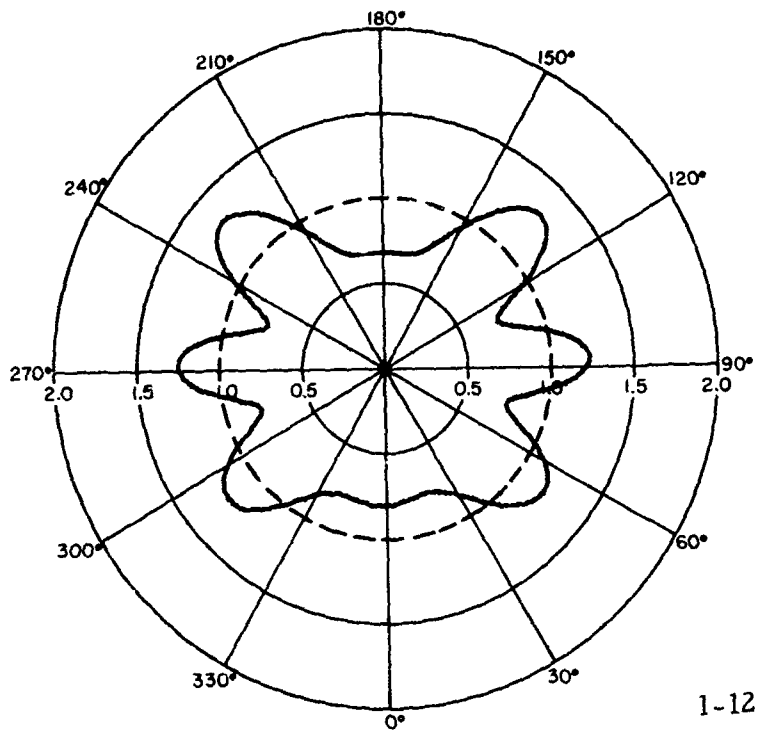


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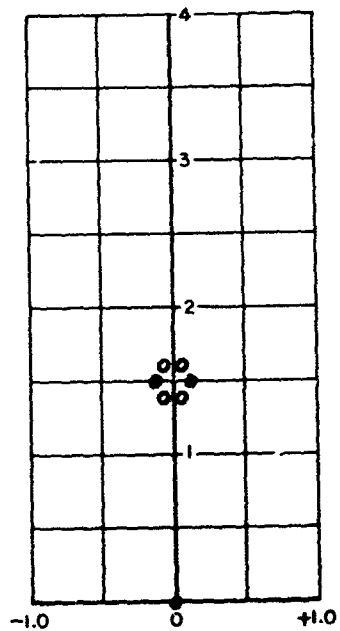




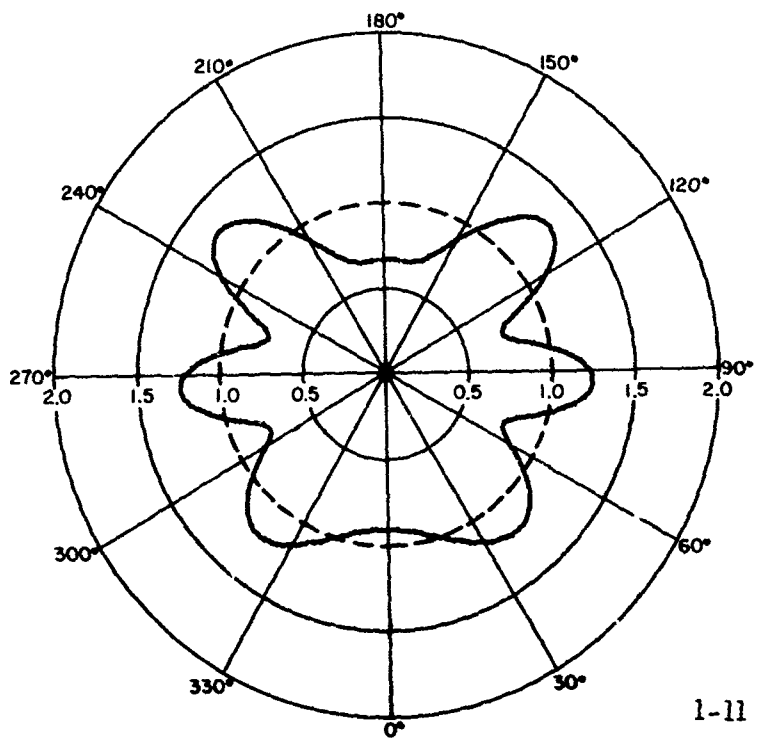
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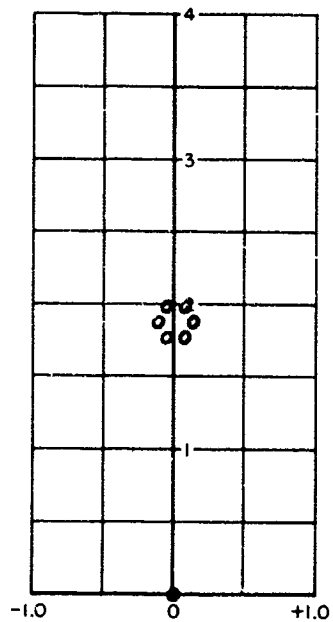
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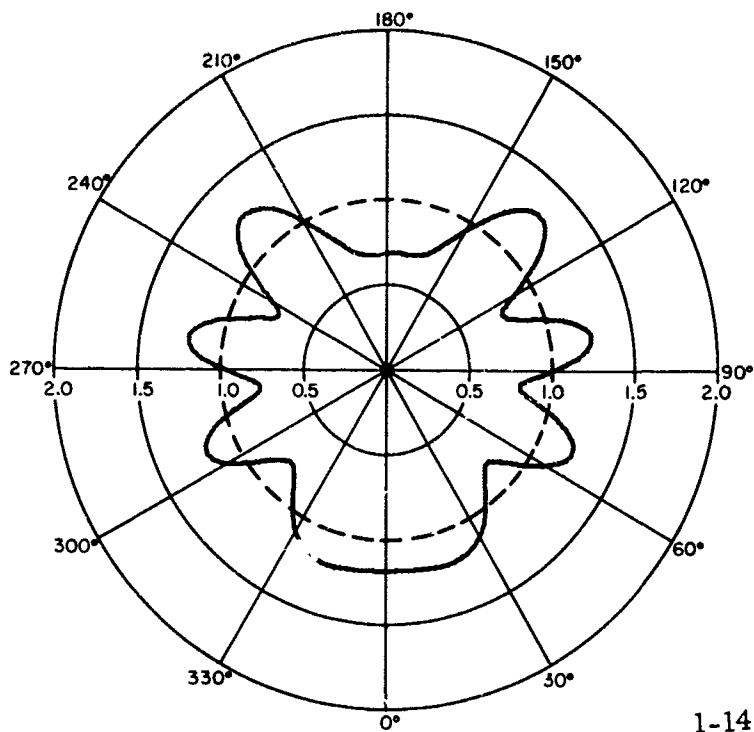
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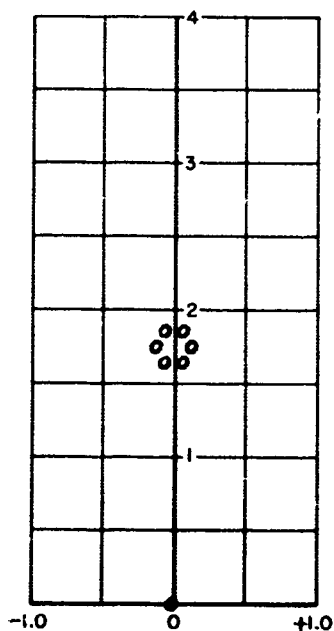
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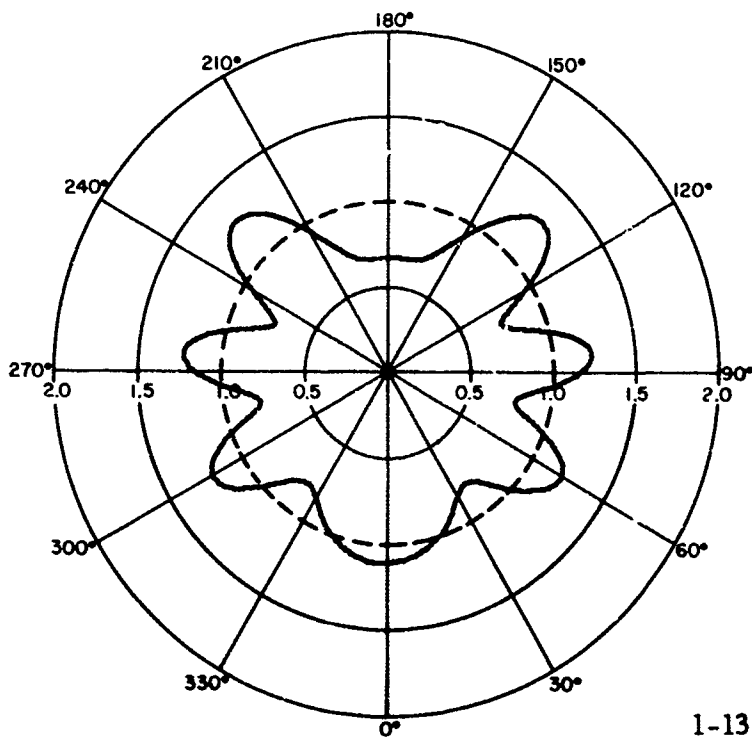
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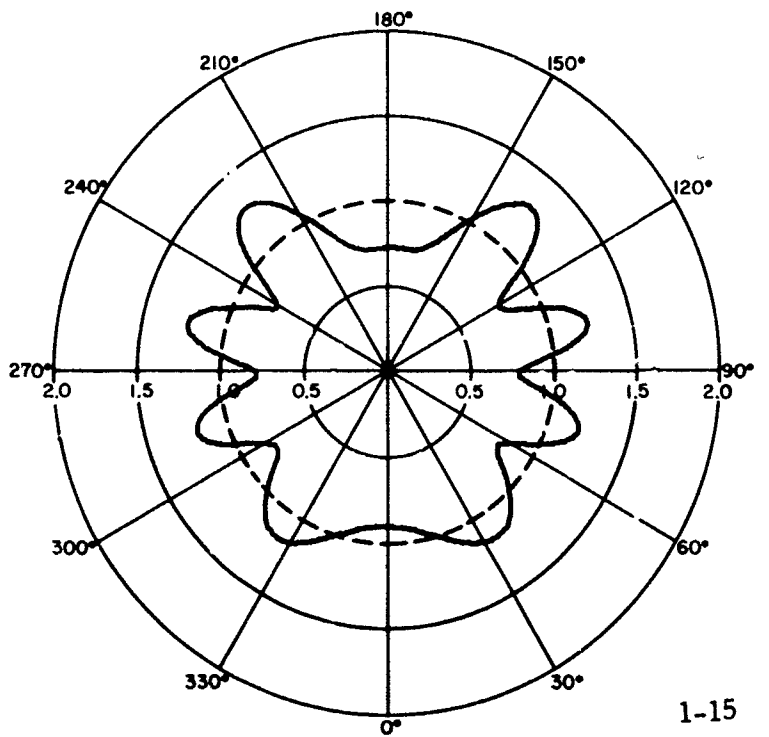
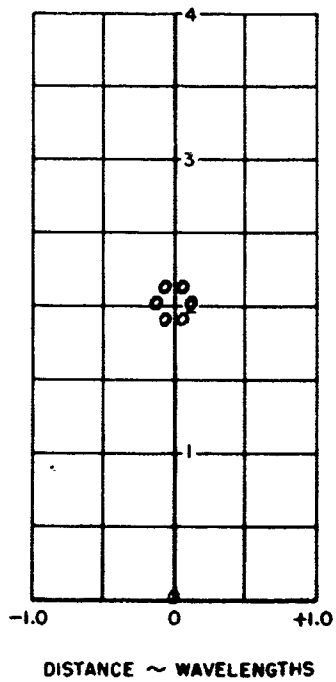
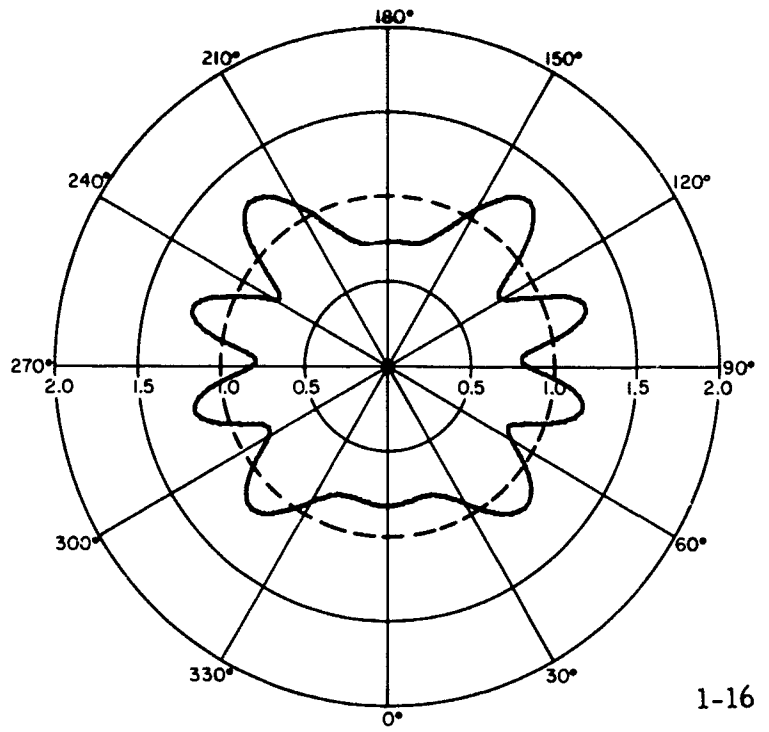
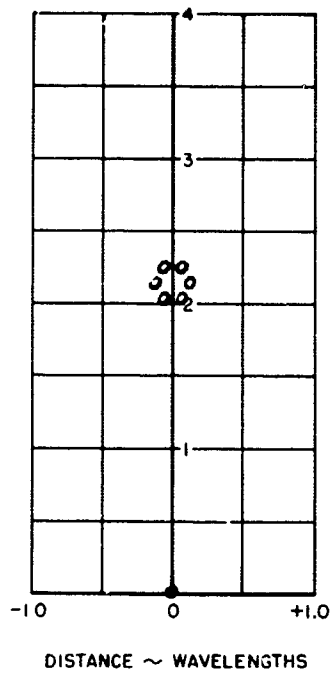
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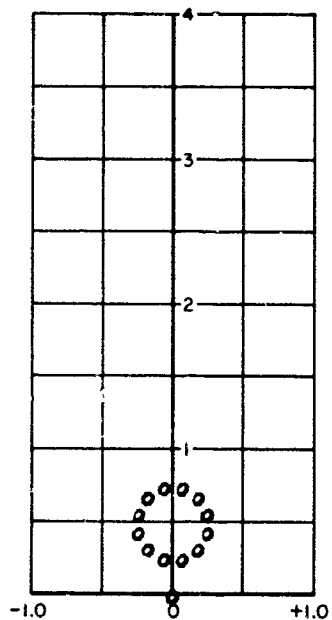


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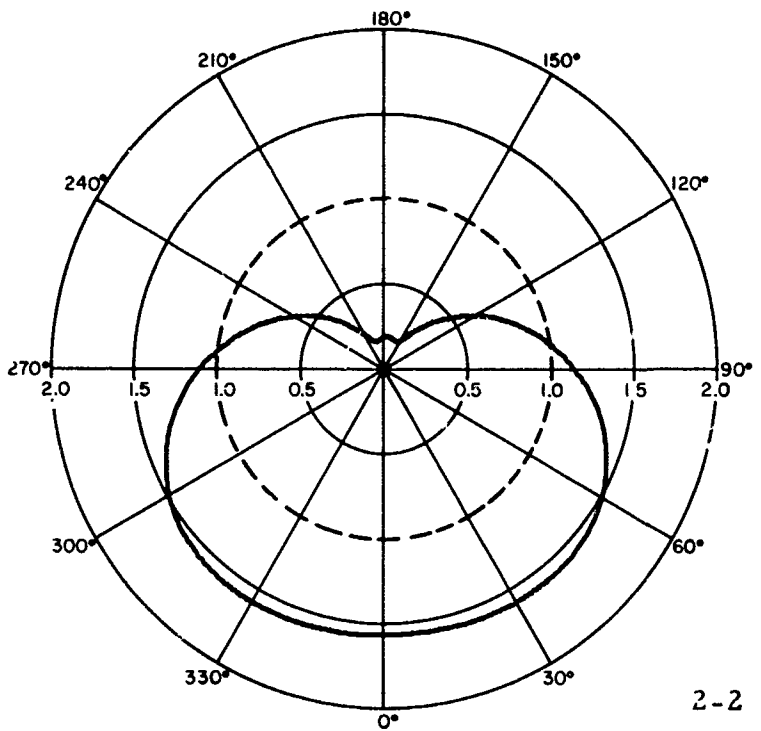


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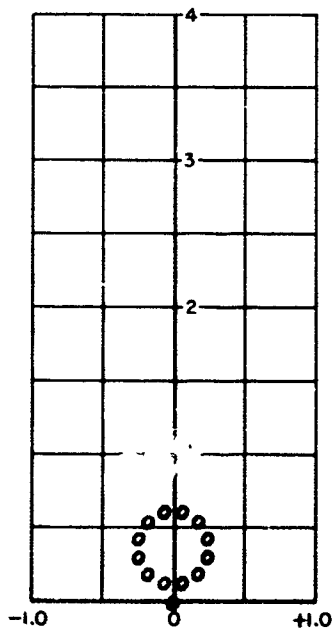




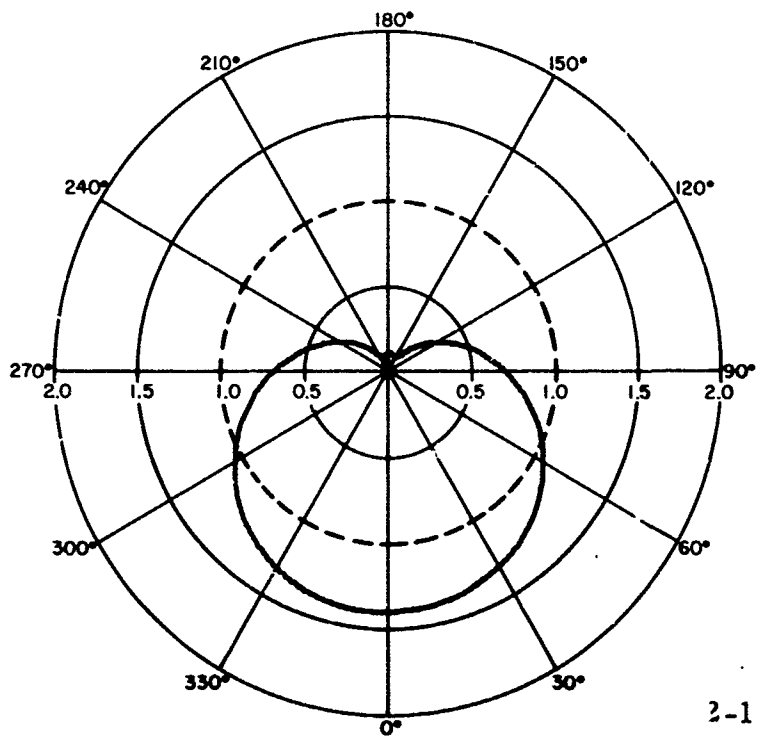
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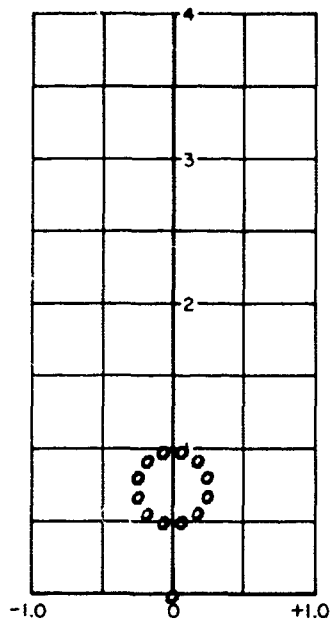
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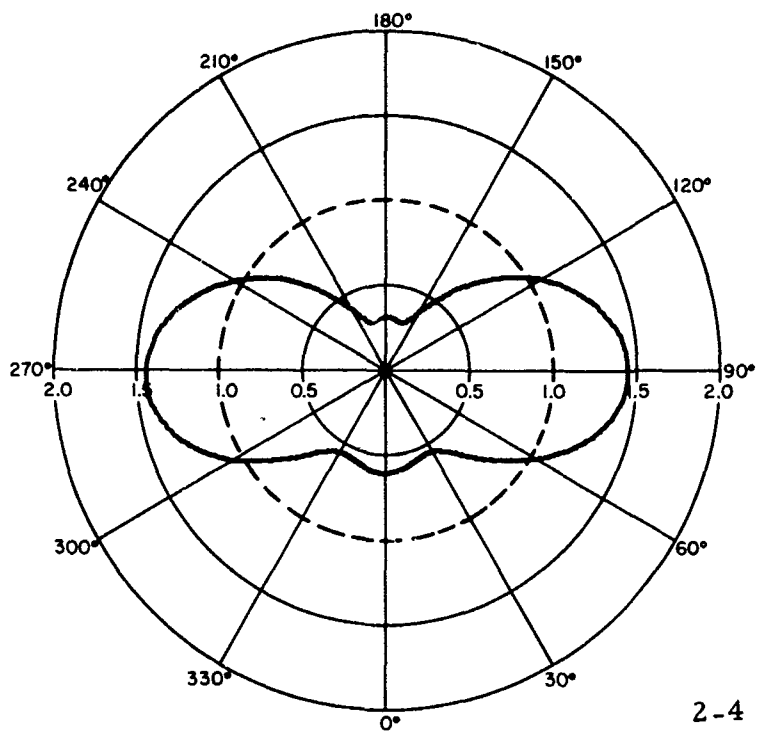
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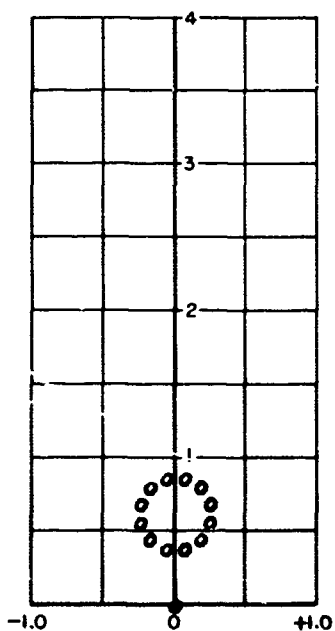
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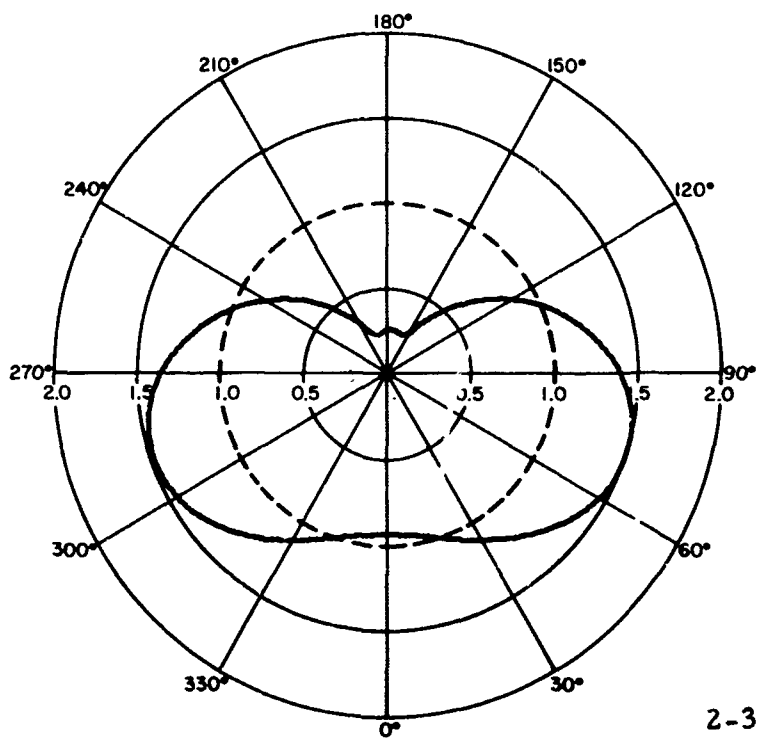
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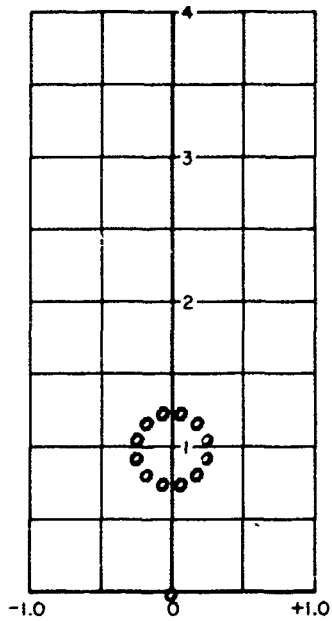
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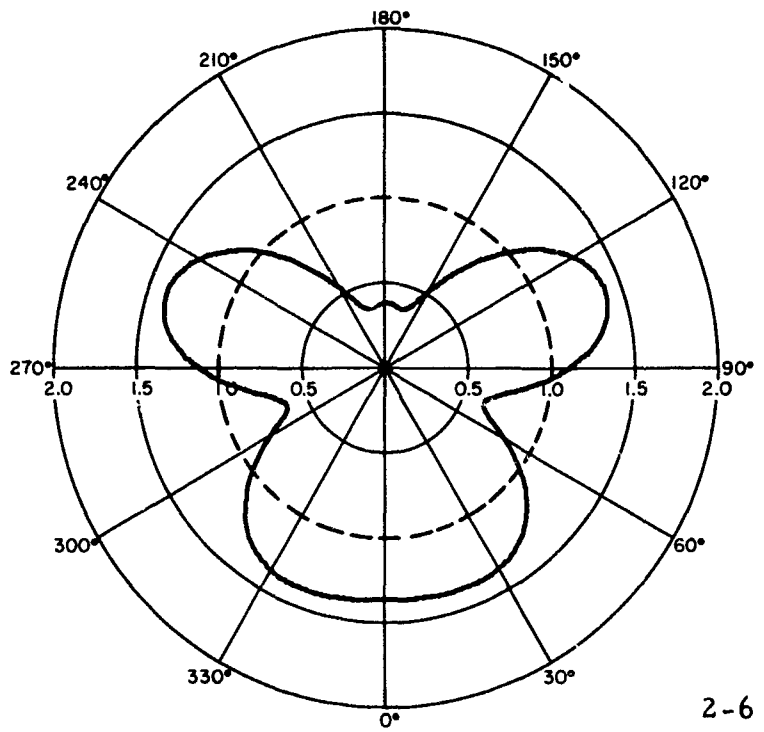
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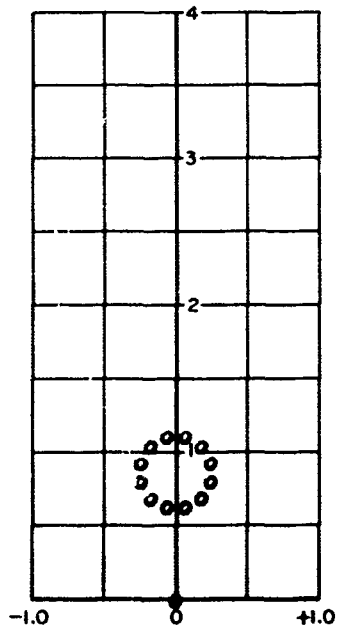
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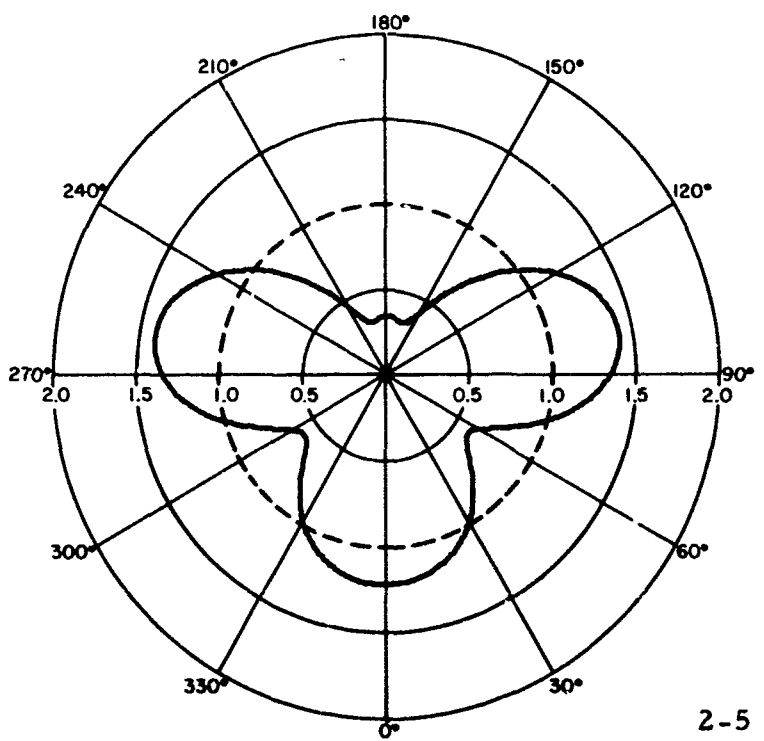
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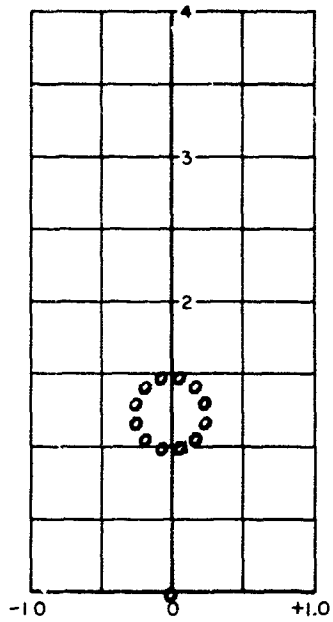


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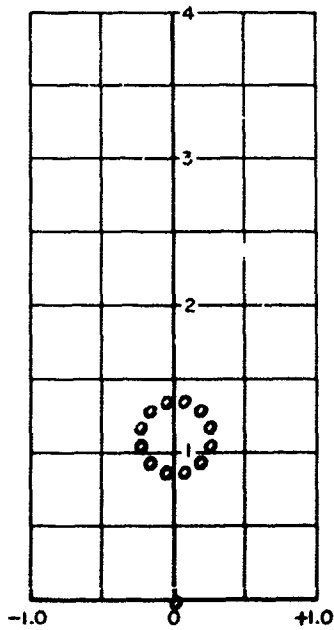
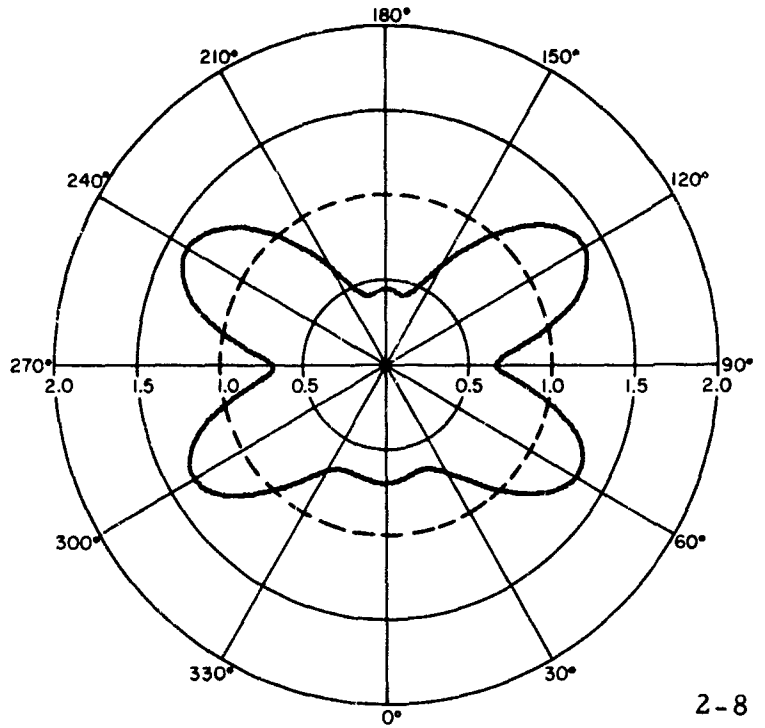


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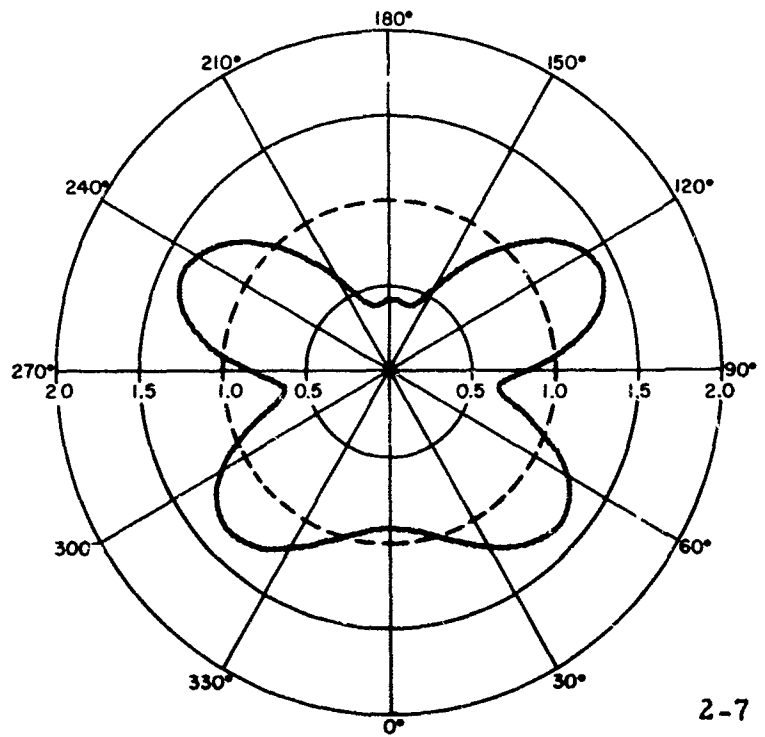


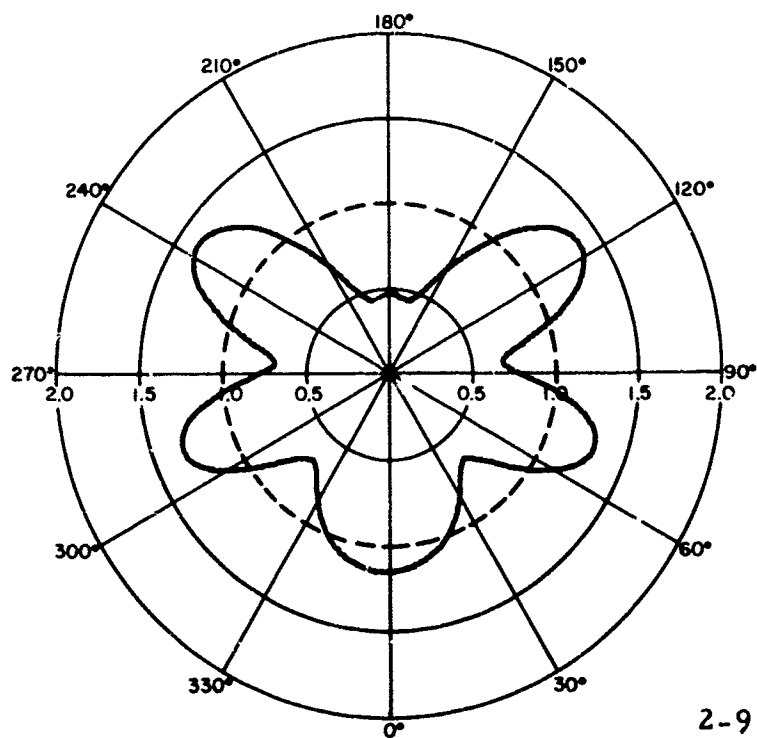
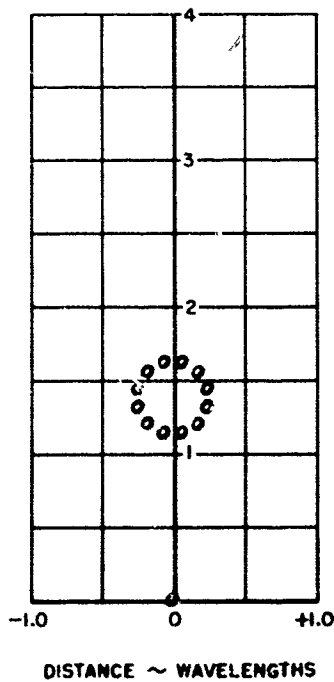
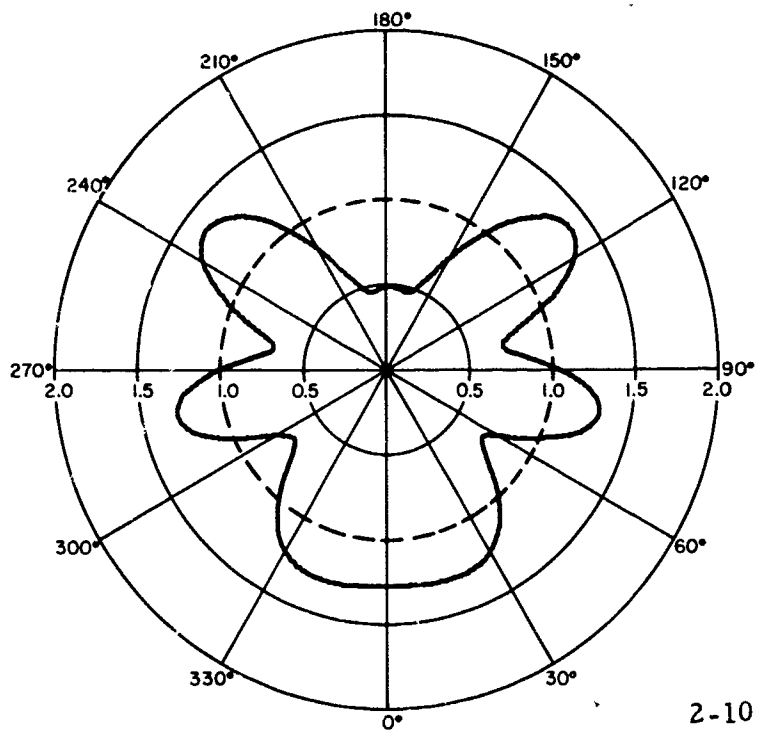
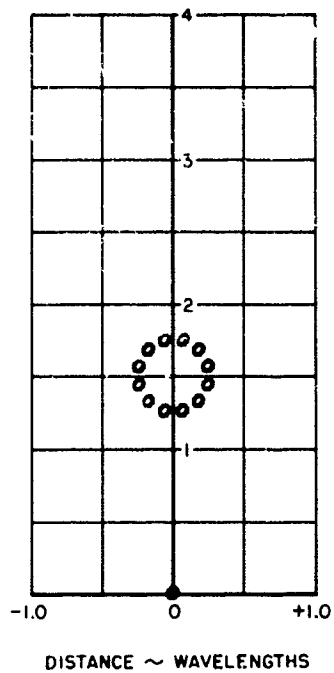


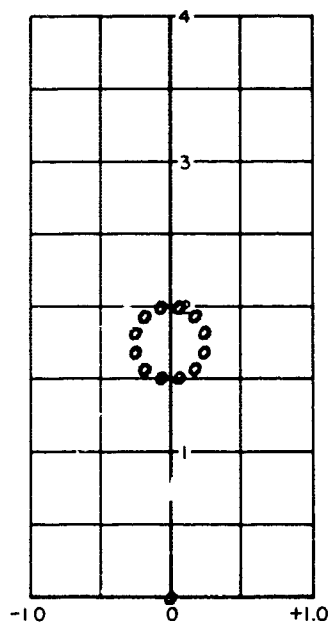
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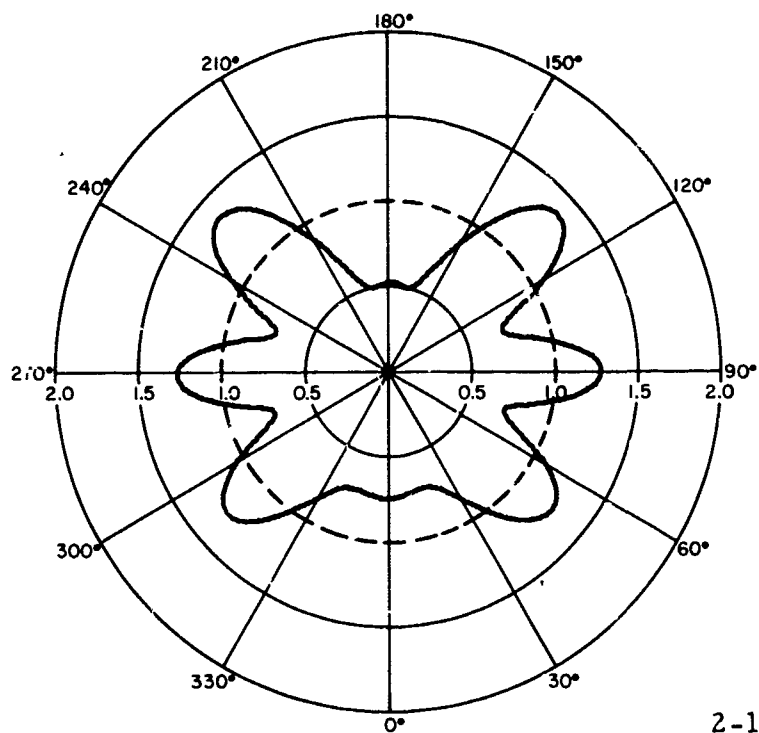
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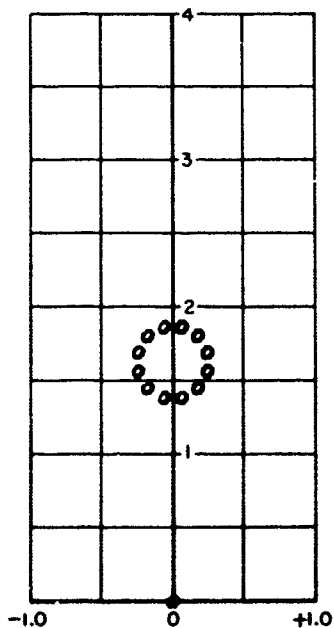




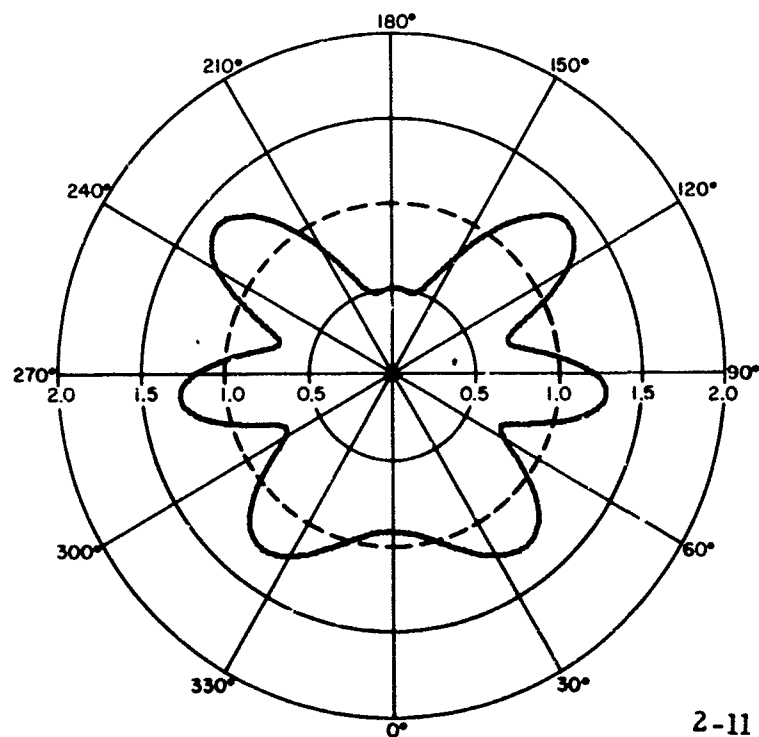
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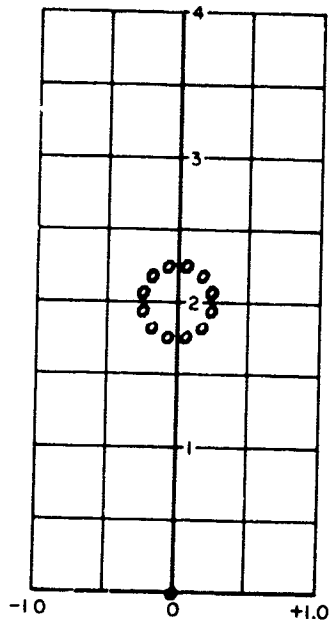
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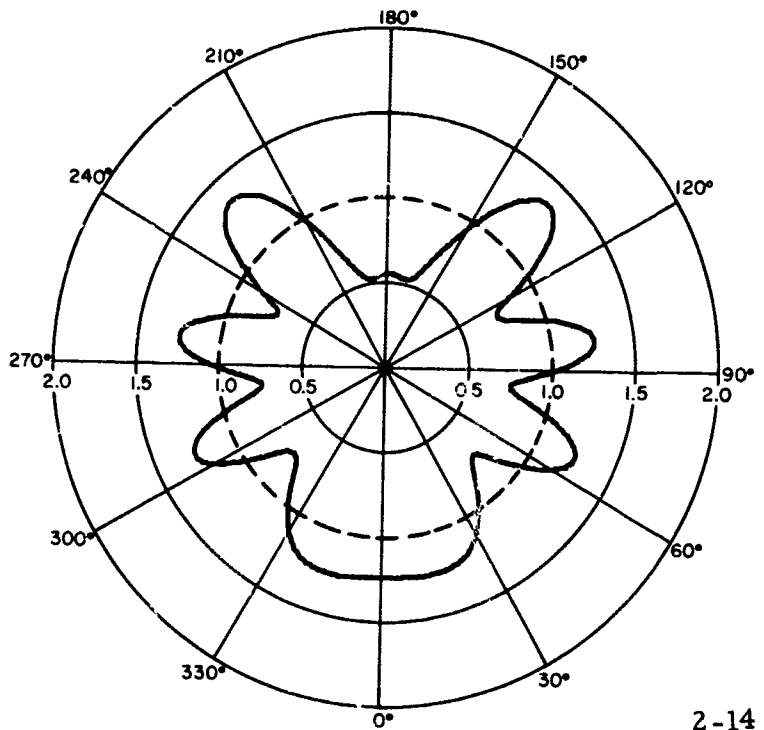
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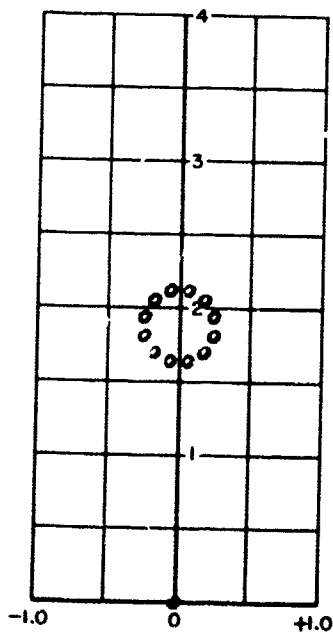
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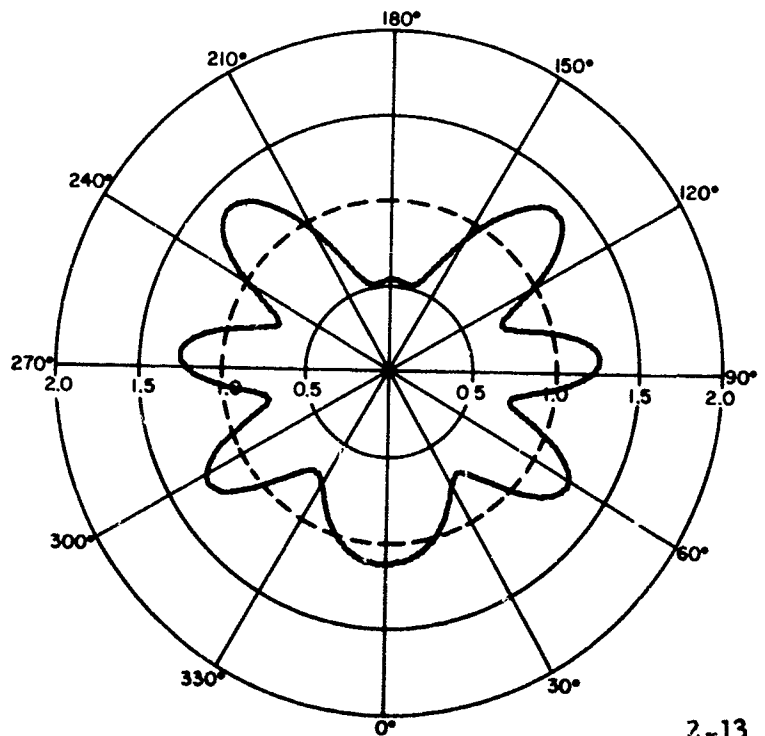
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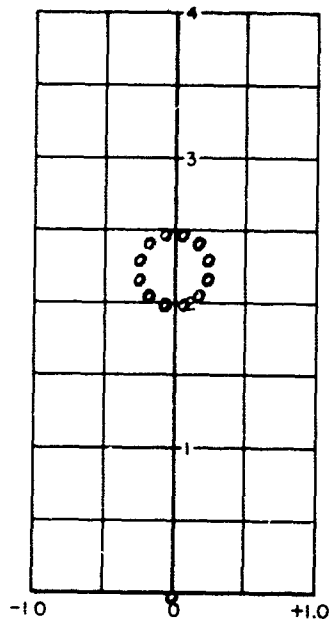
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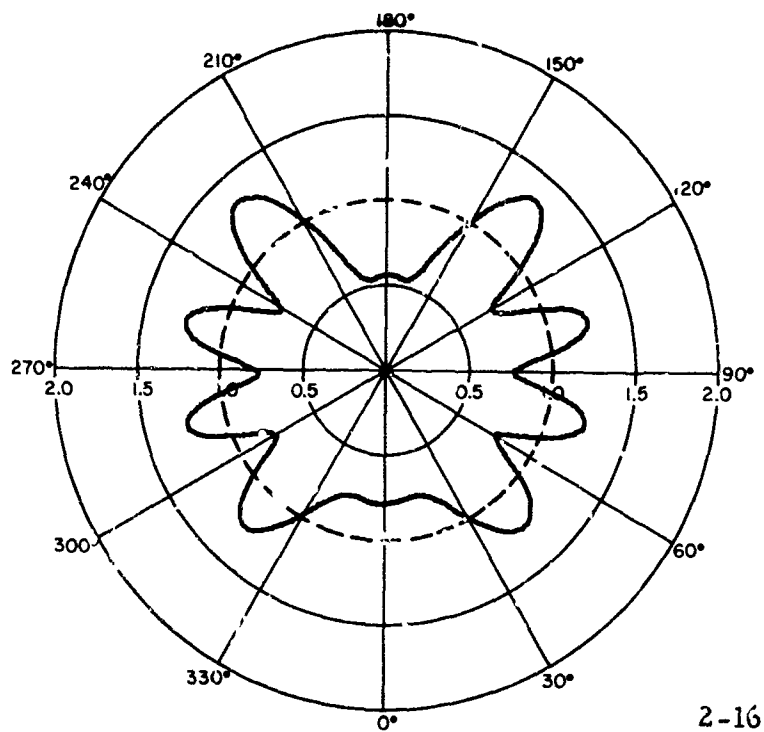
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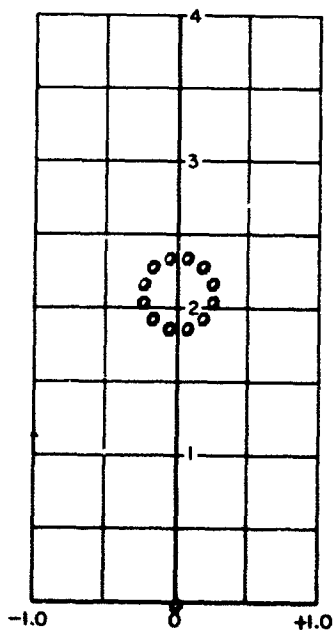
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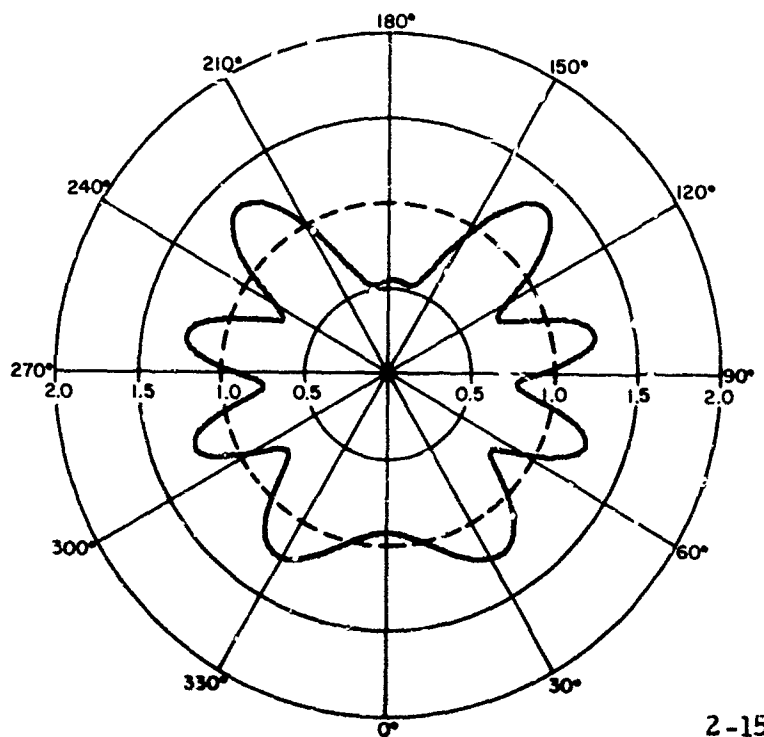
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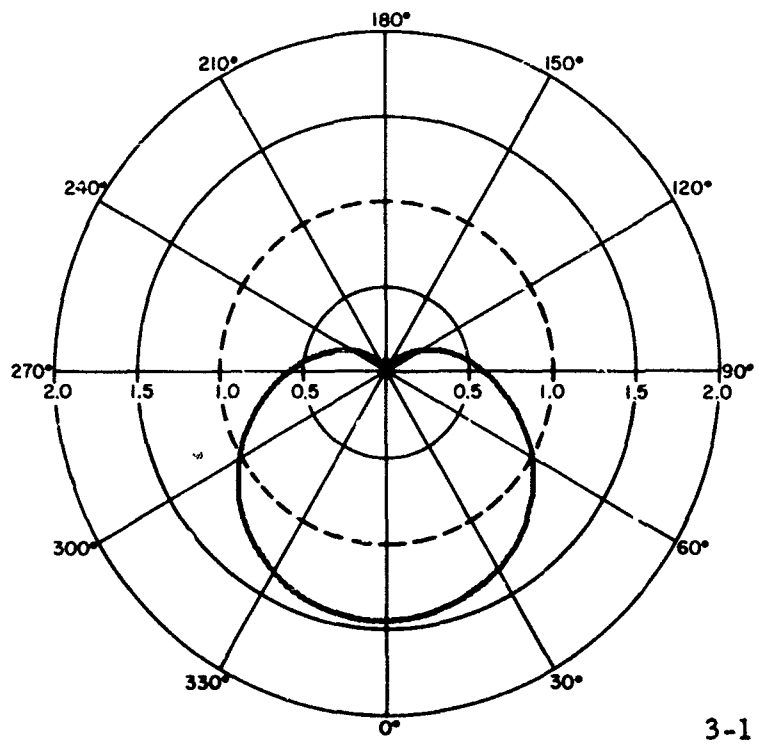
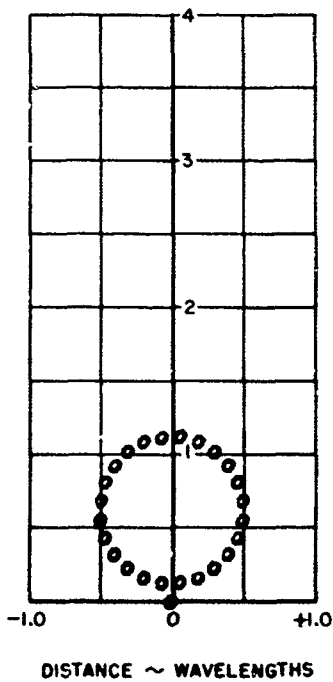
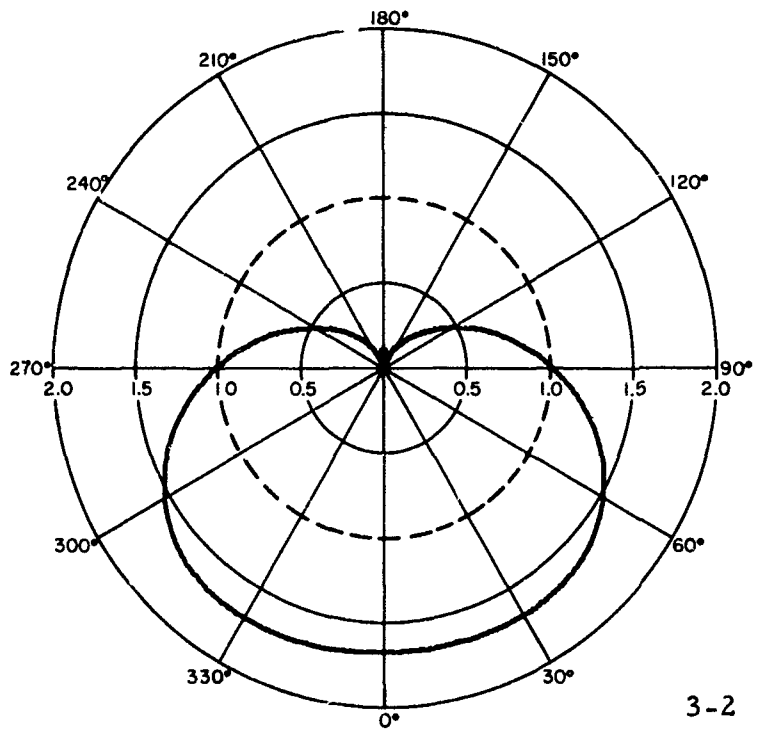
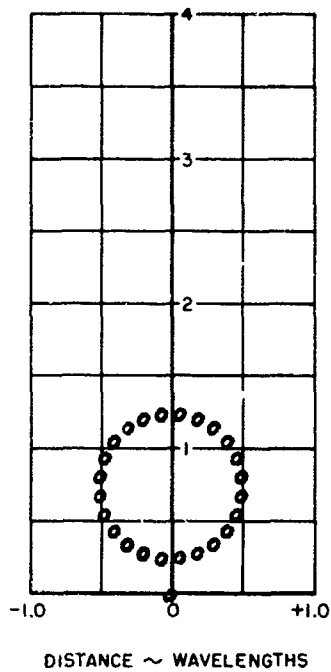
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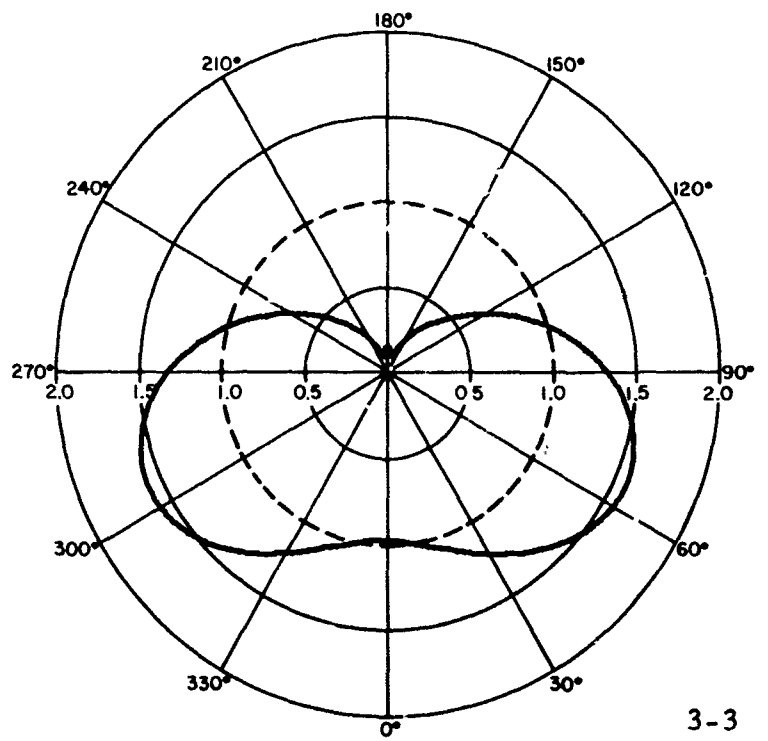
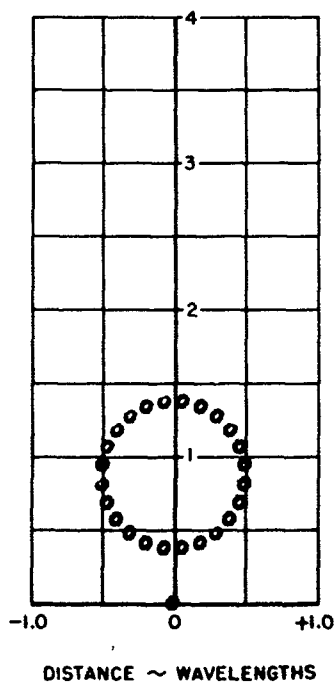
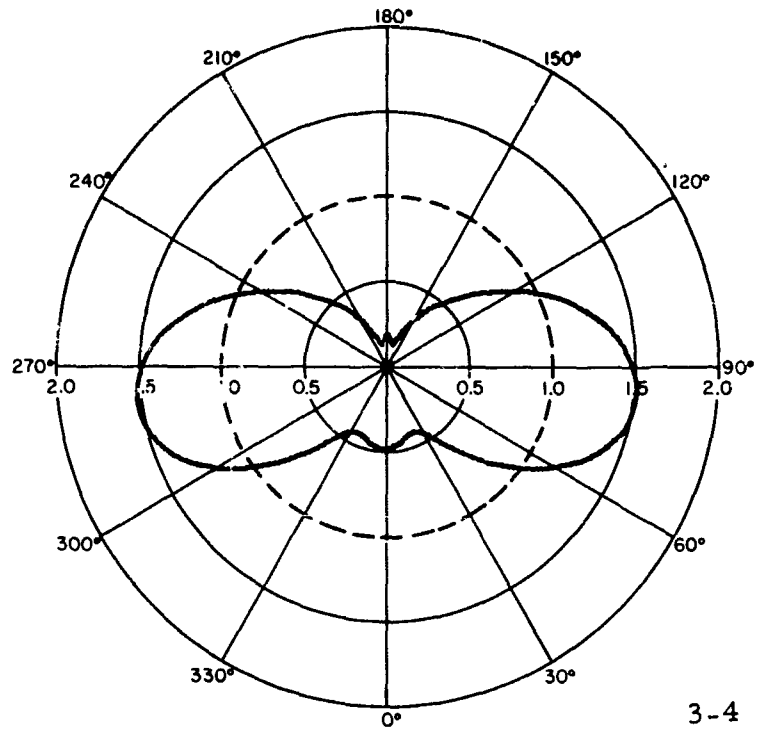
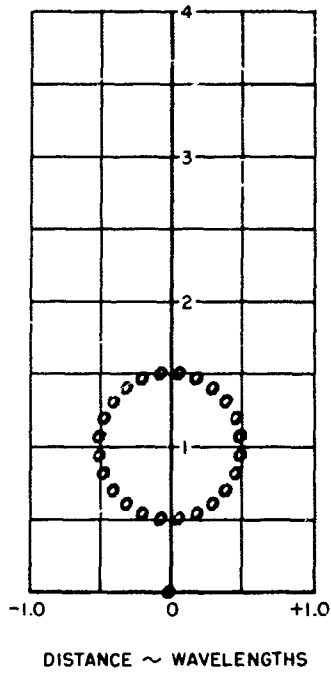


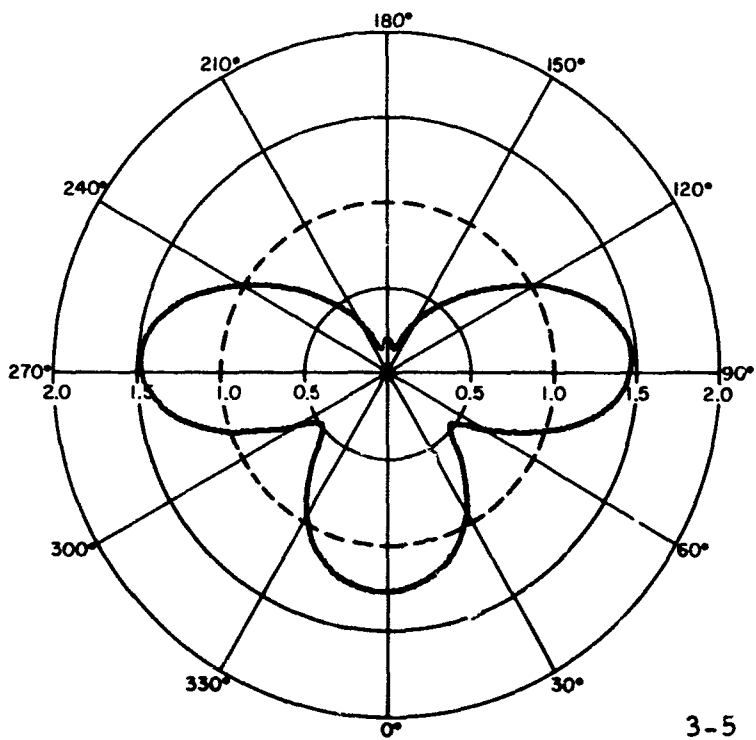
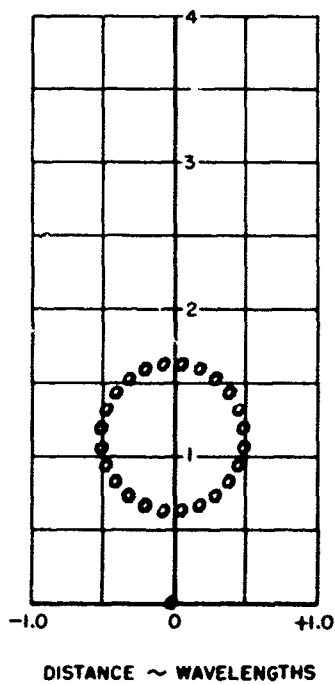
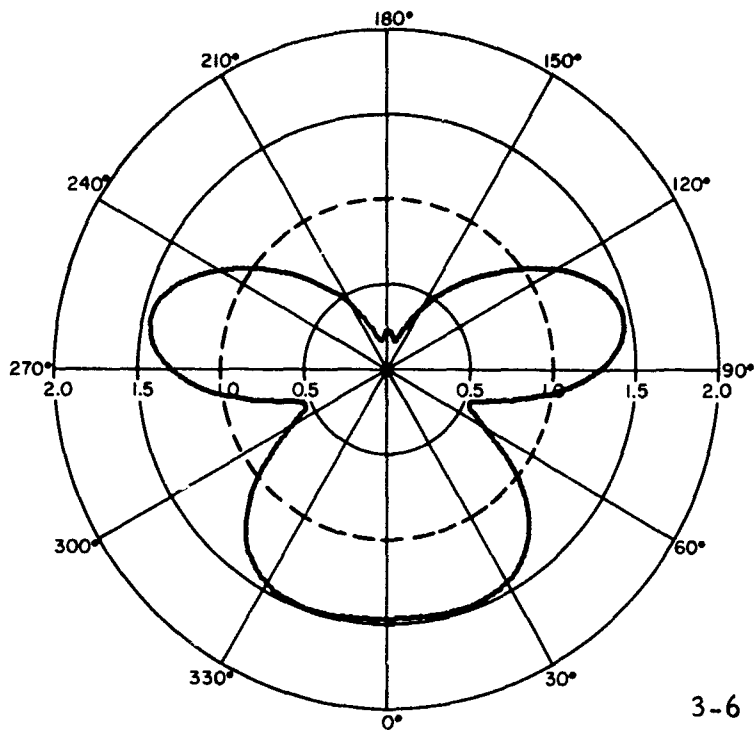
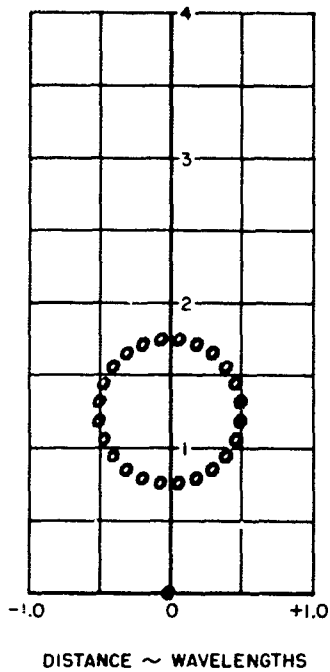
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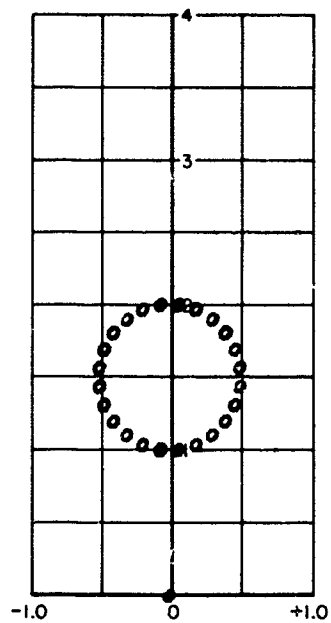
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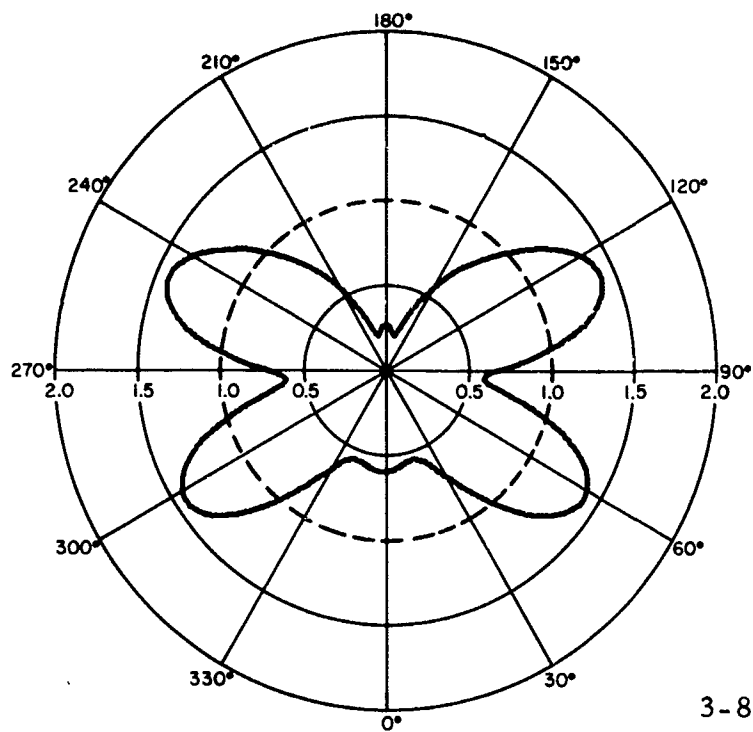




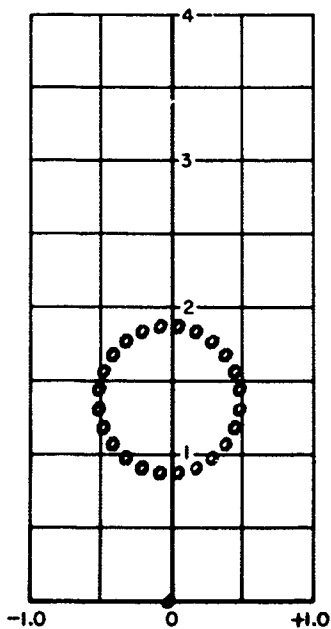




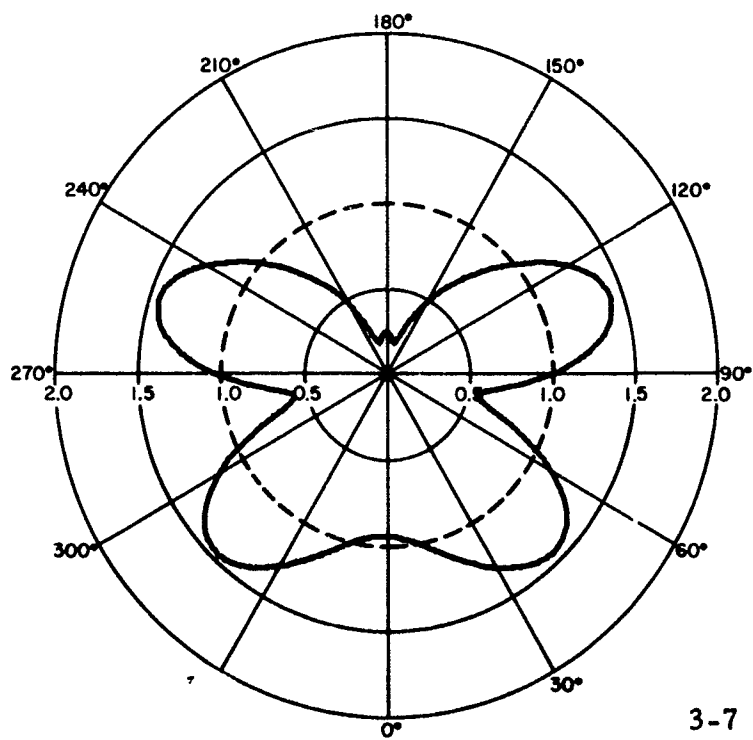
DISTANCE ~ WAVELENGTHS



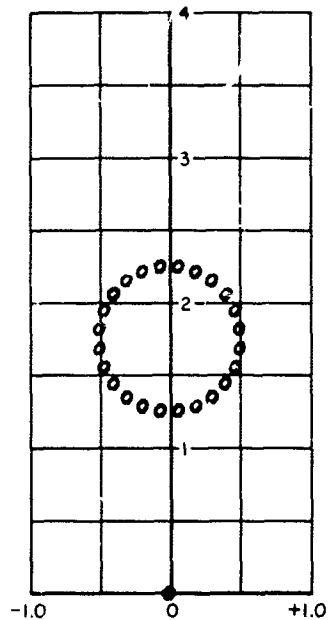
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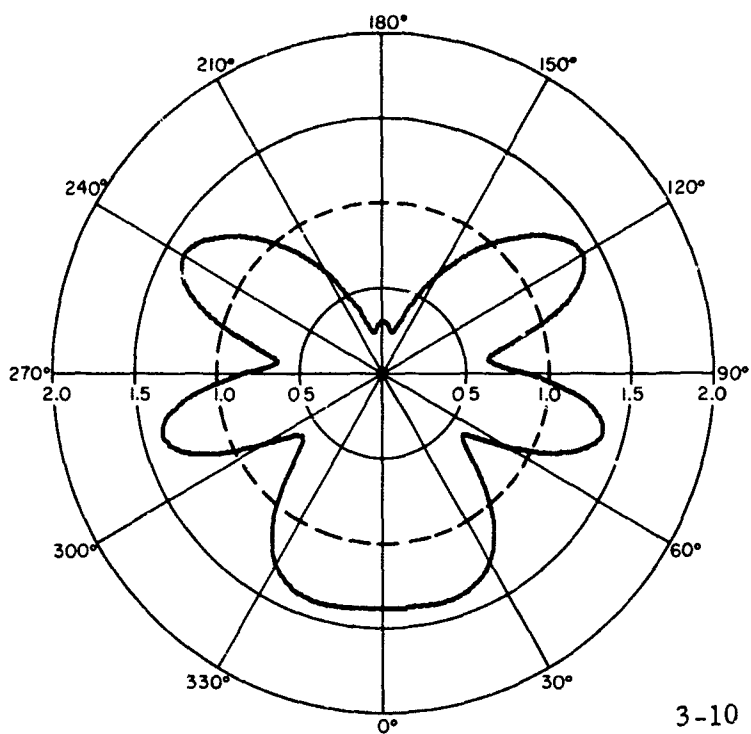
DISTANCE ~ WAVELENGTHS



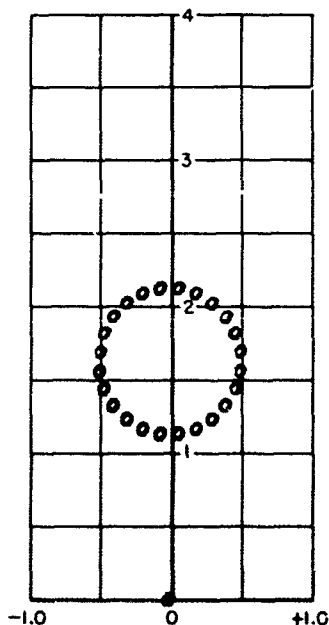
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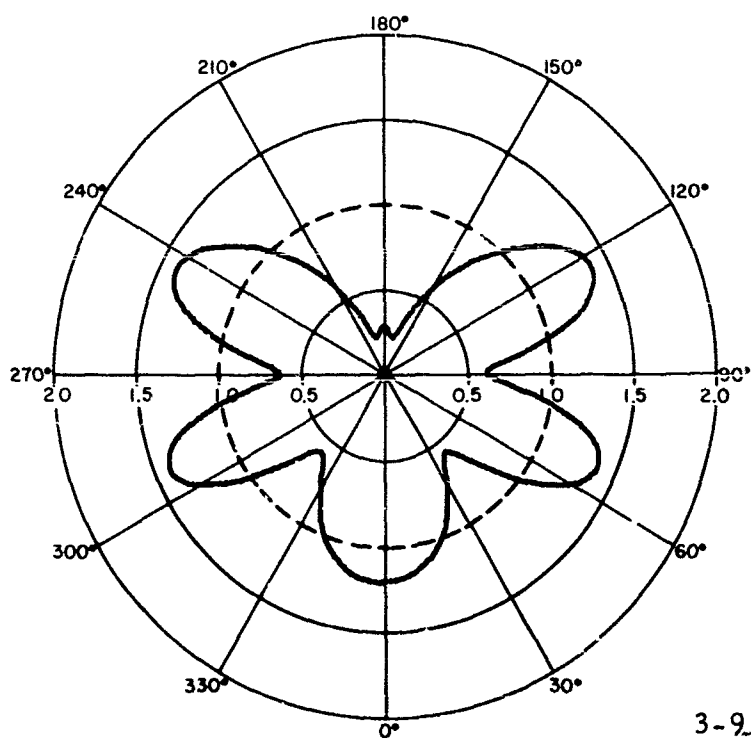
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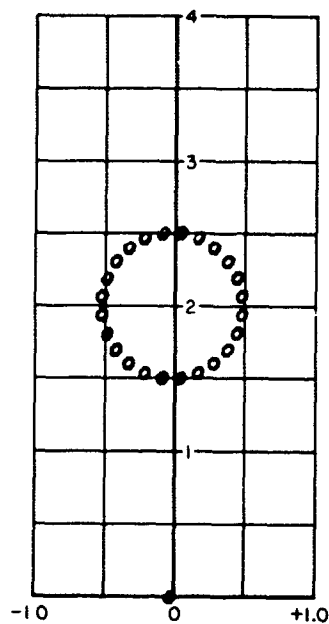
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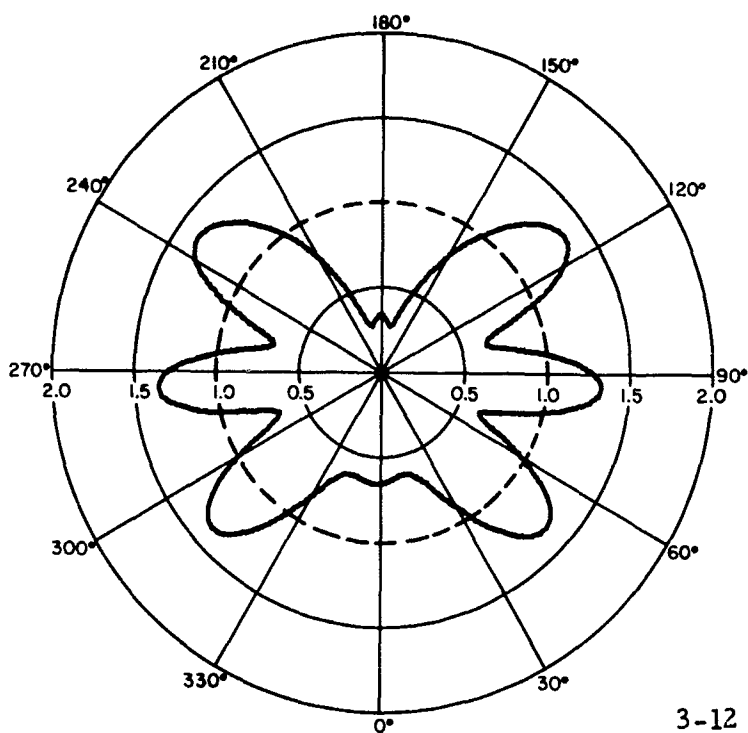
DISTANCE ~ WAVELENGTHS



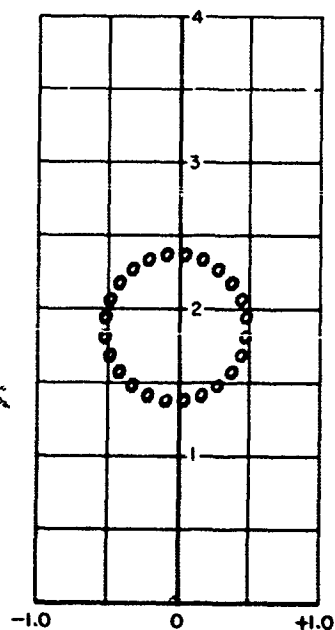
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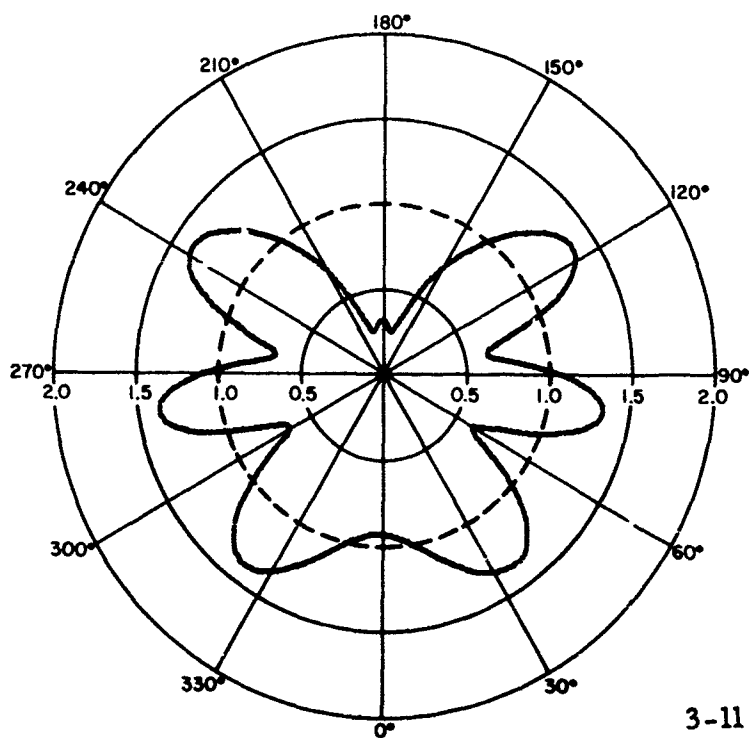
DISTANCE ~ WAVELENGTHS



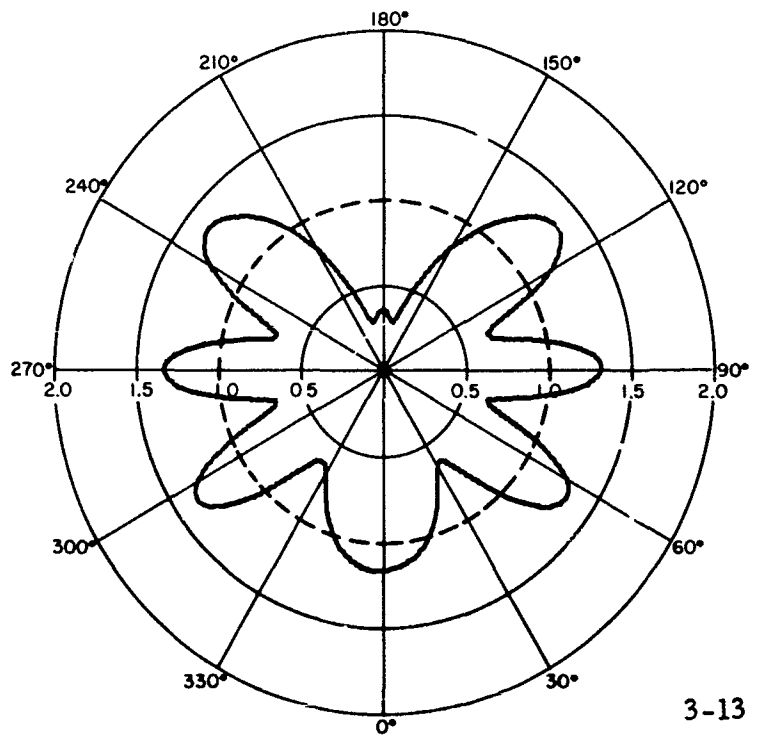
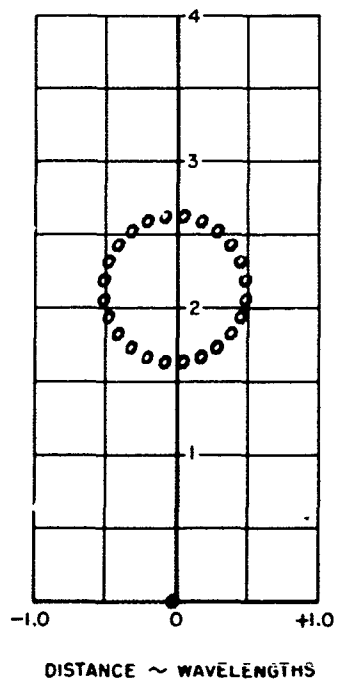
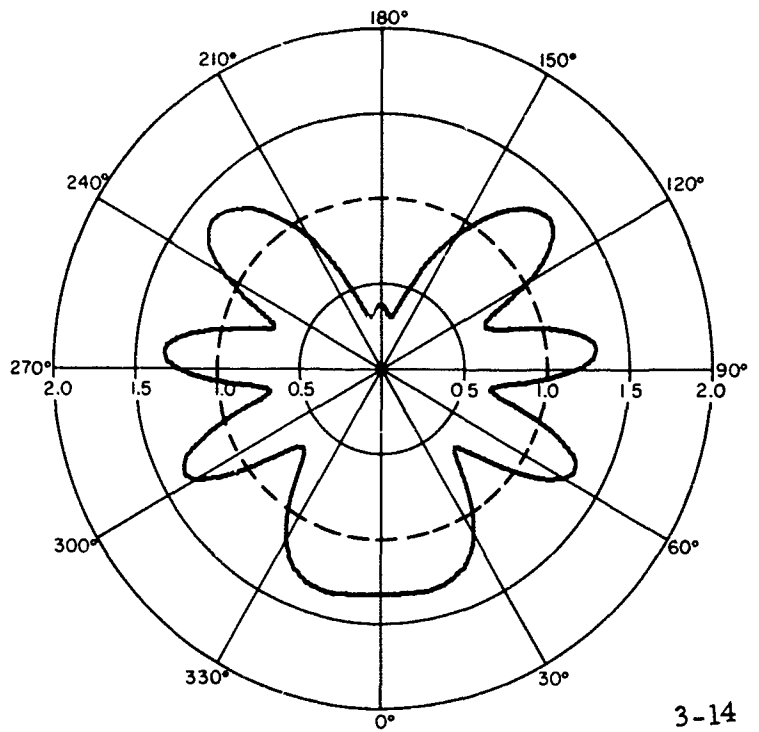
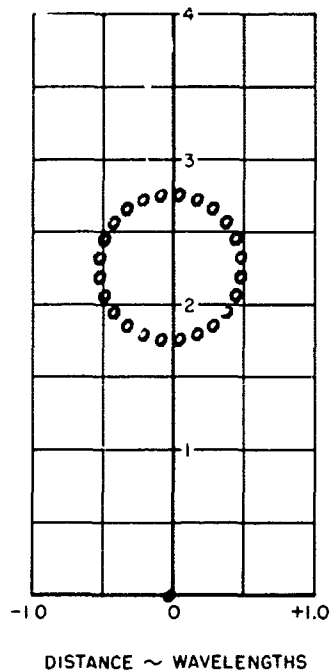
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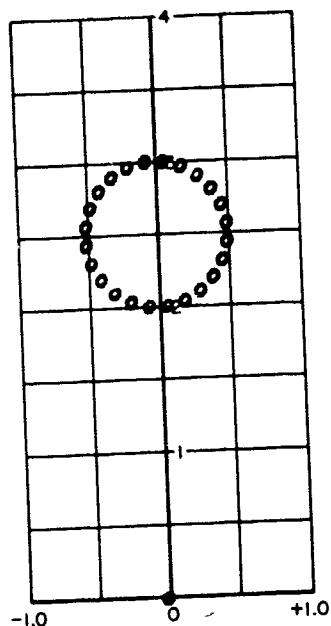


DISTANCE ~ WAVELENGTHS

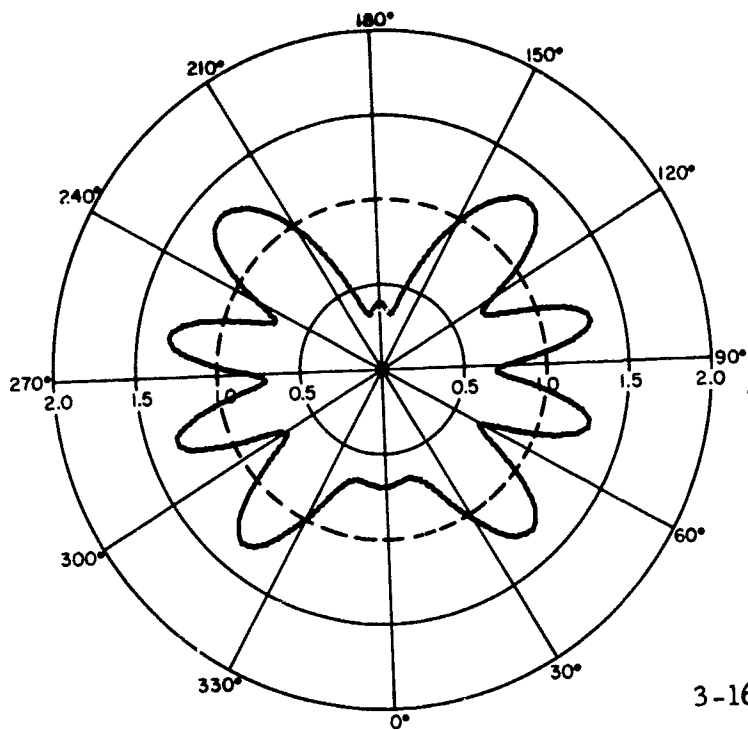


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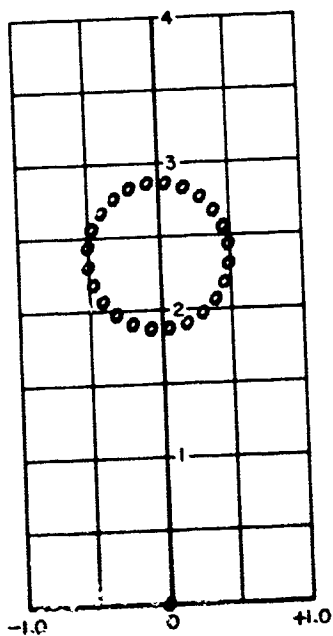




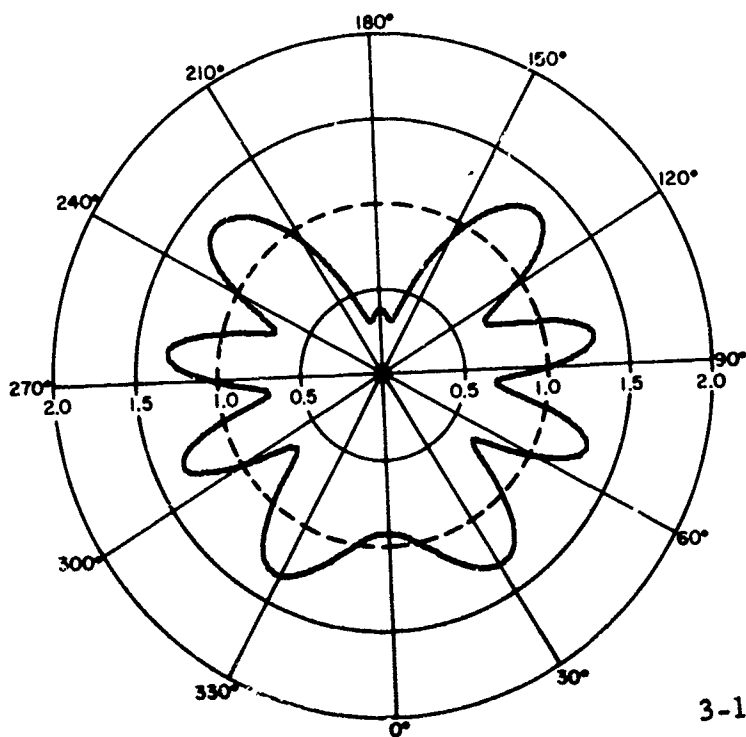
DISTANCE ~ WAVELENGTHS



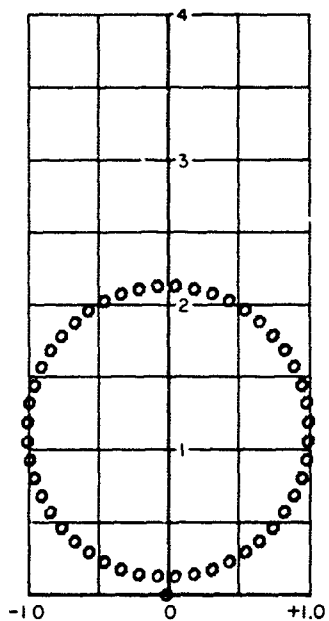
3-16



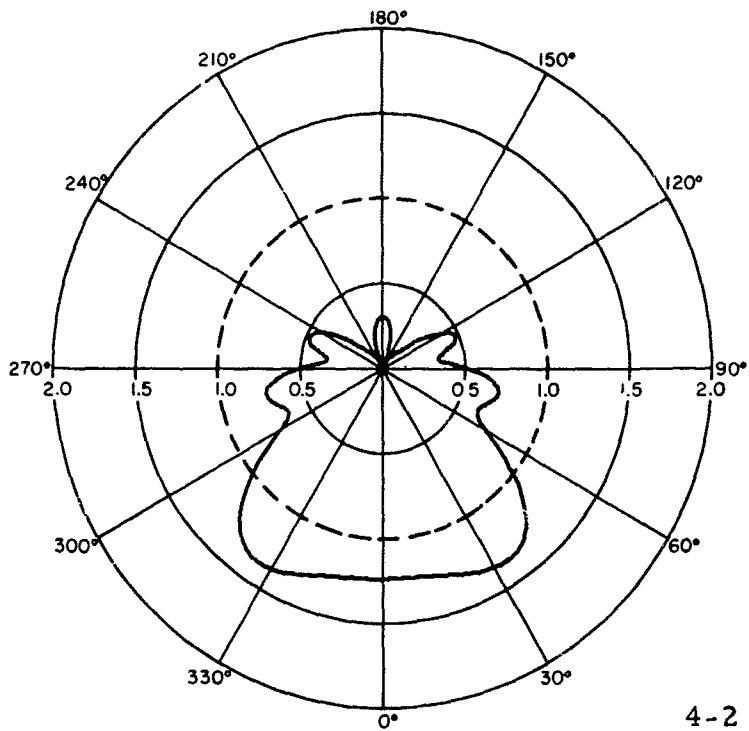
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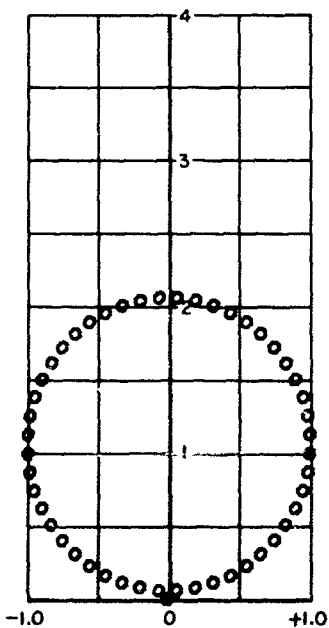
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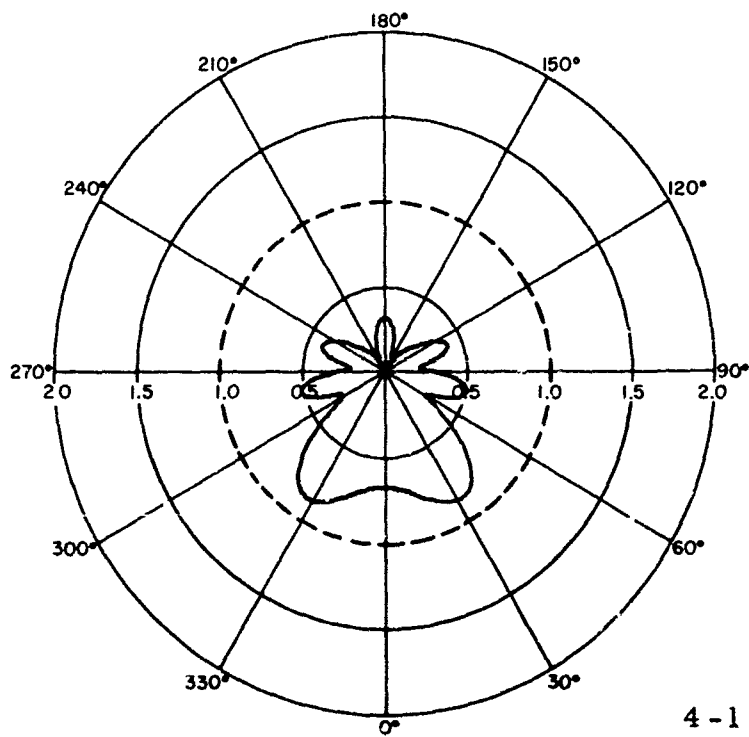
DISTANCE ~ WAVELENGTHS



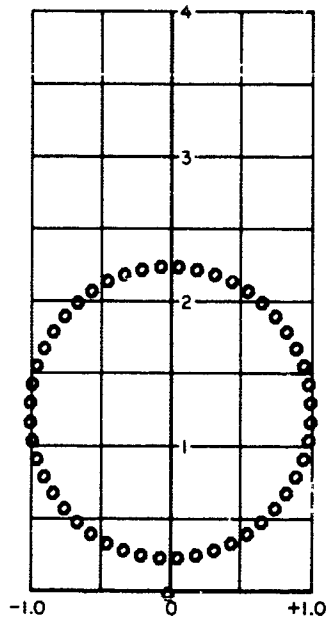
4-2



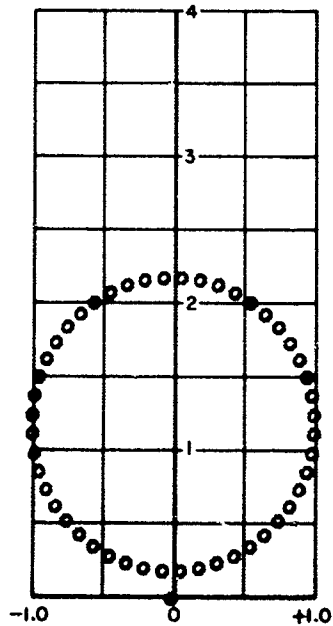
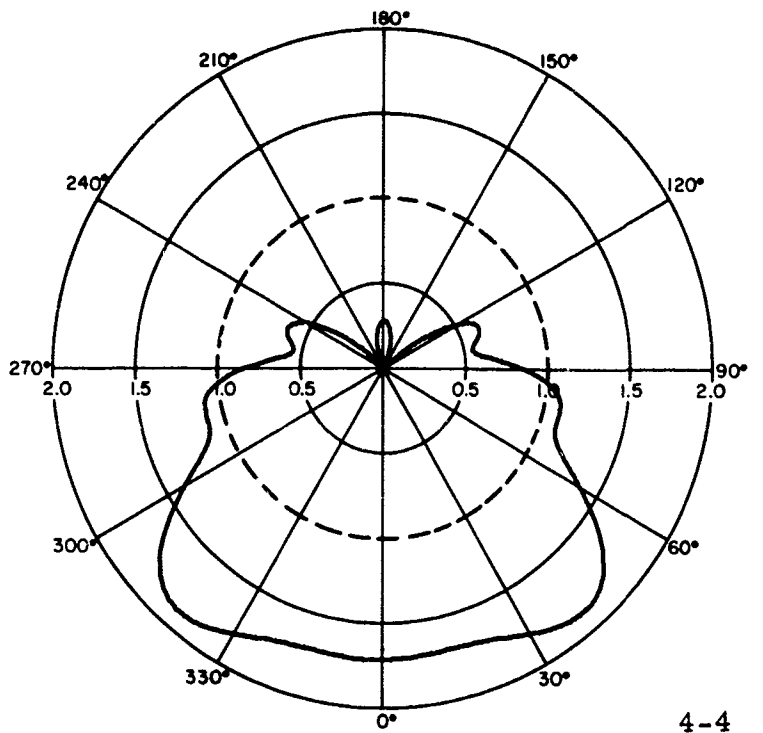
DISTANCE ~ WAVELENGTHS



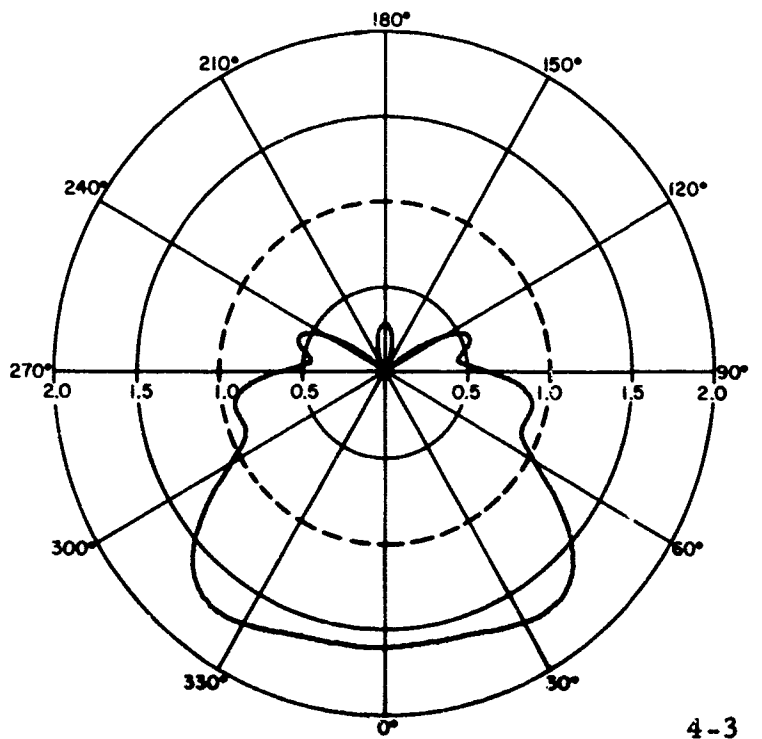
4-1

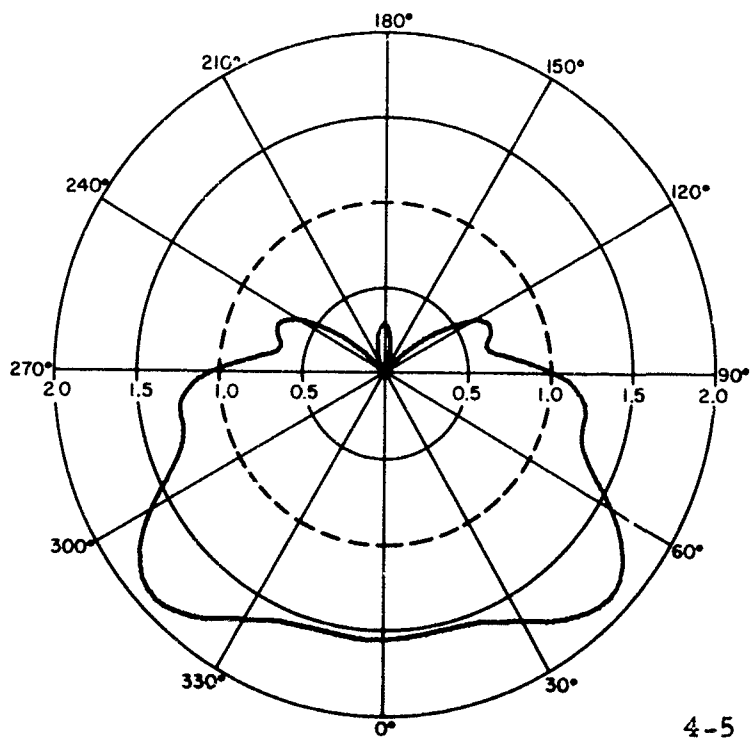
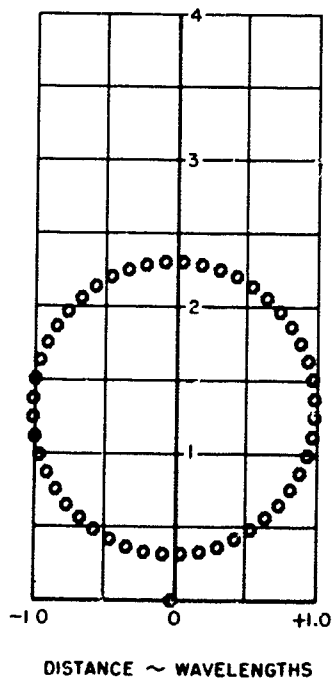
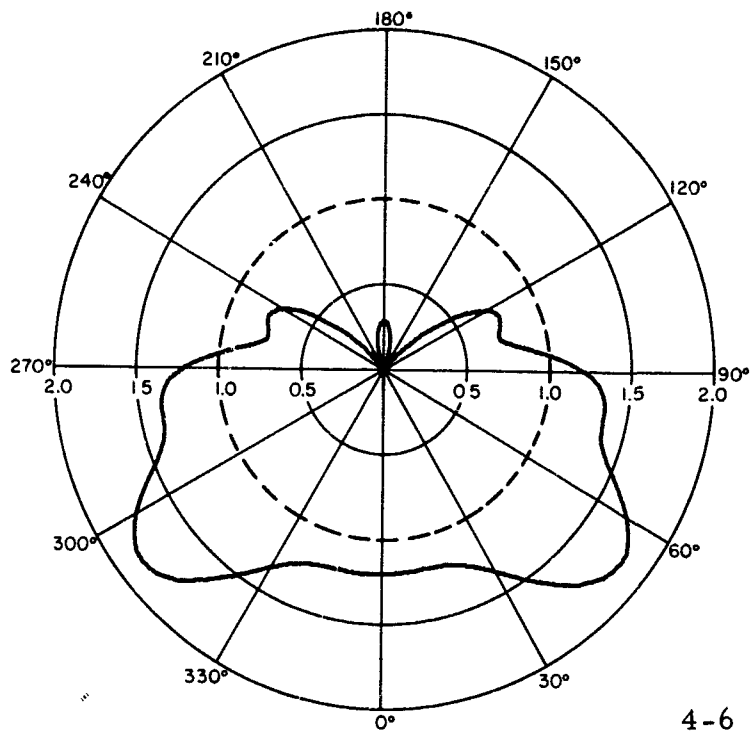
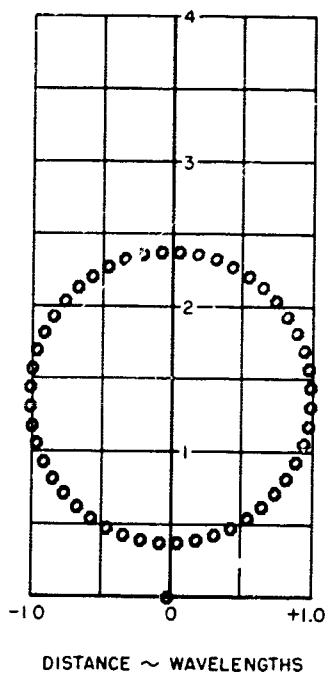


DISTANCE ~ WAVELENGTHS

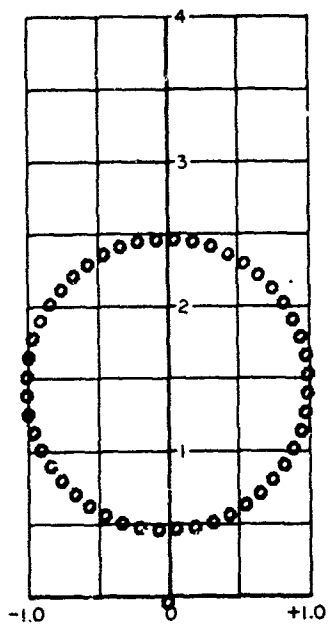


DISTANCE ~ WAVELENGTHS

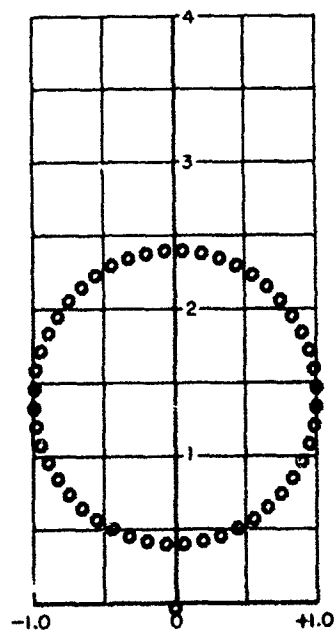
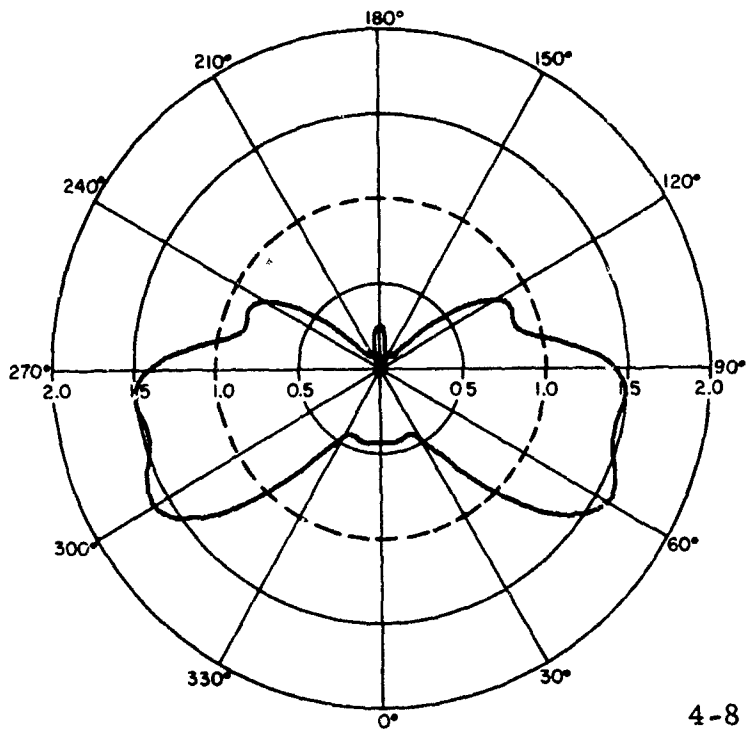




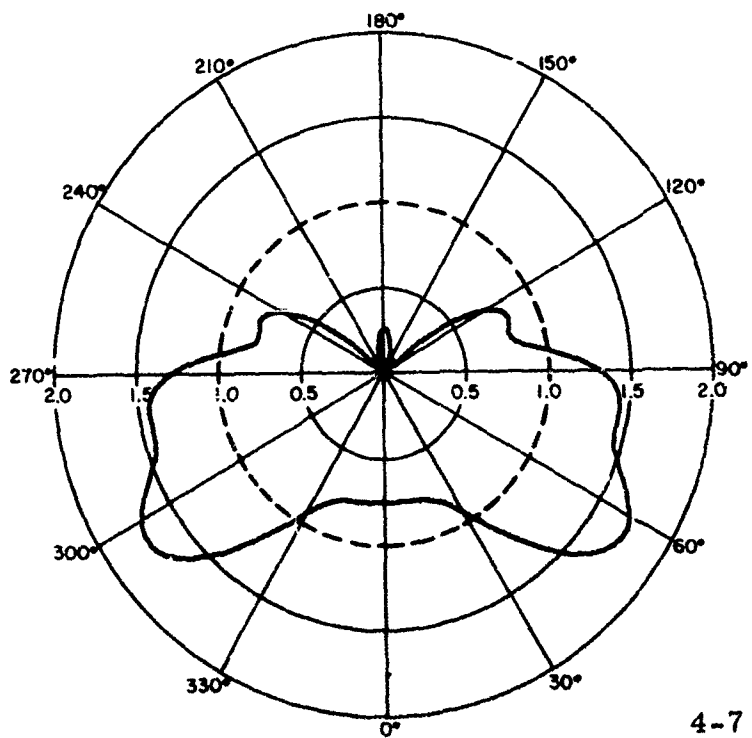


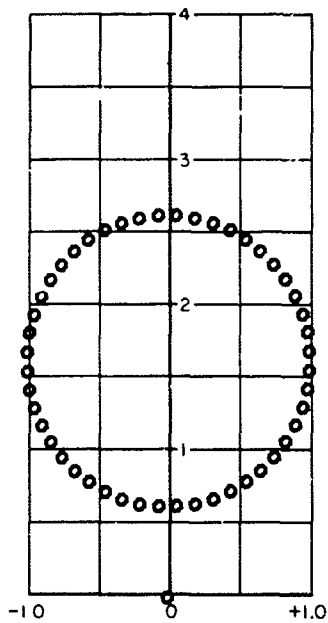


DISTANCE ~ WAVELENGTHS

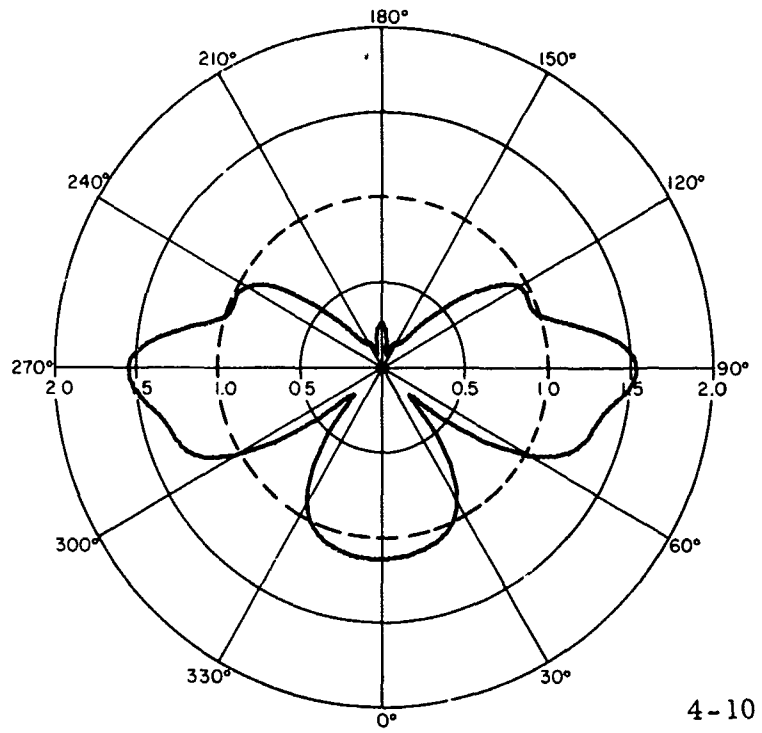


DISTANCE ~ WAVELENGTHS

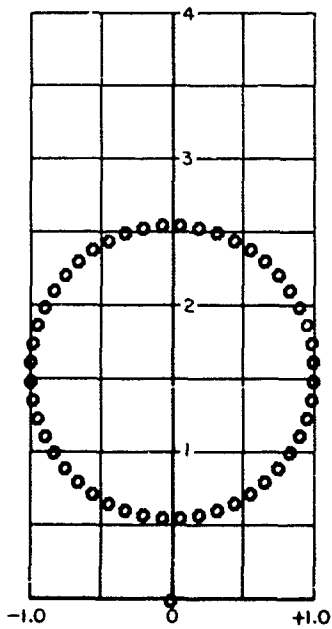




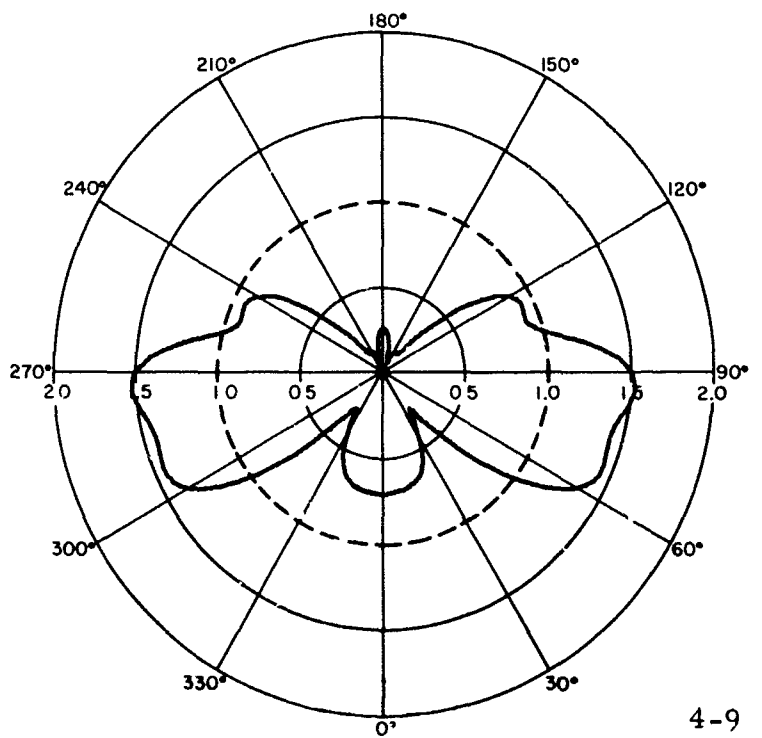
DISTANCE ~ WAVELENGTHS



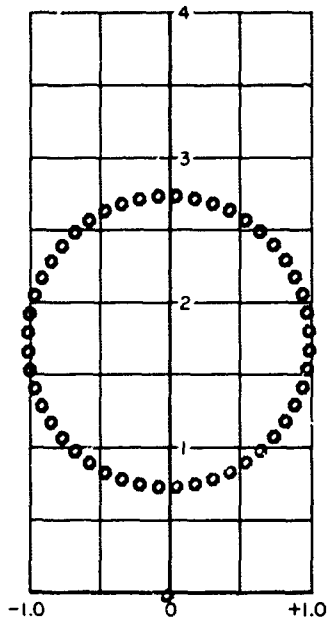
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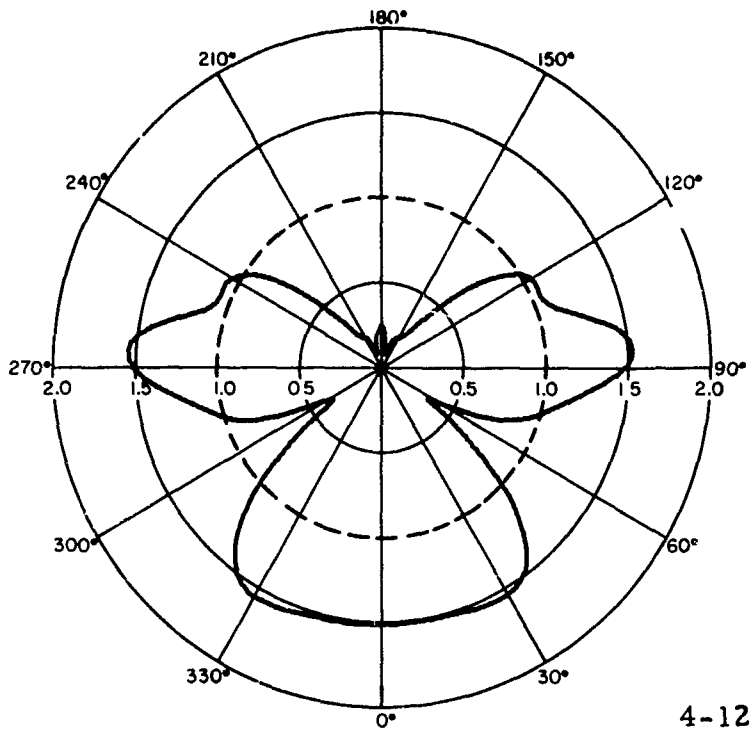
DISTANCE ~ WAVELENGTHS



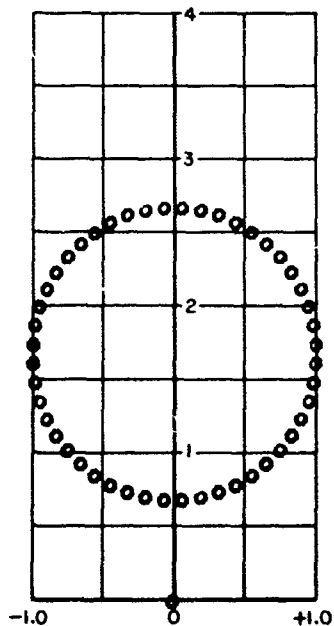
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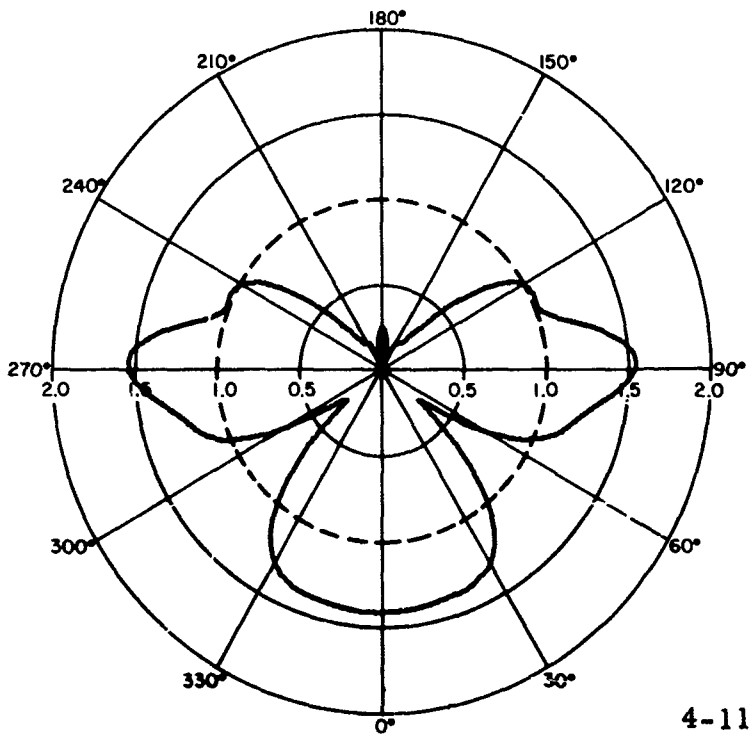
DISTANCE ~ WAVELENGTHS



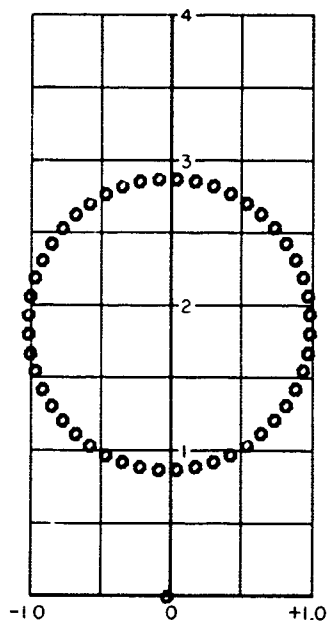
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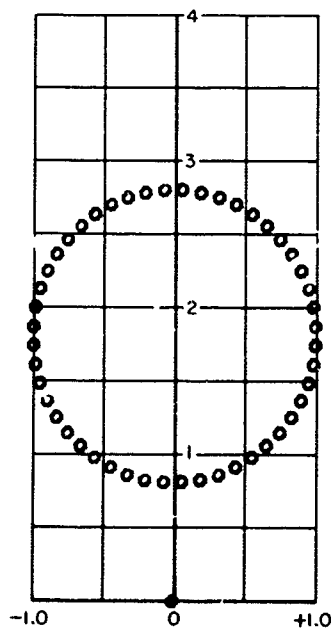
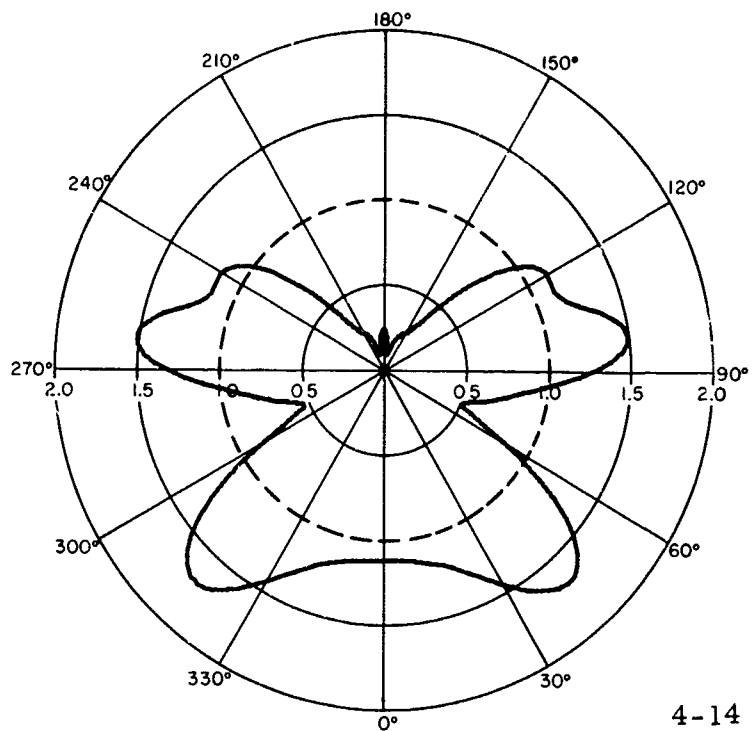
DISTANCE ~ WAVELENGTHS



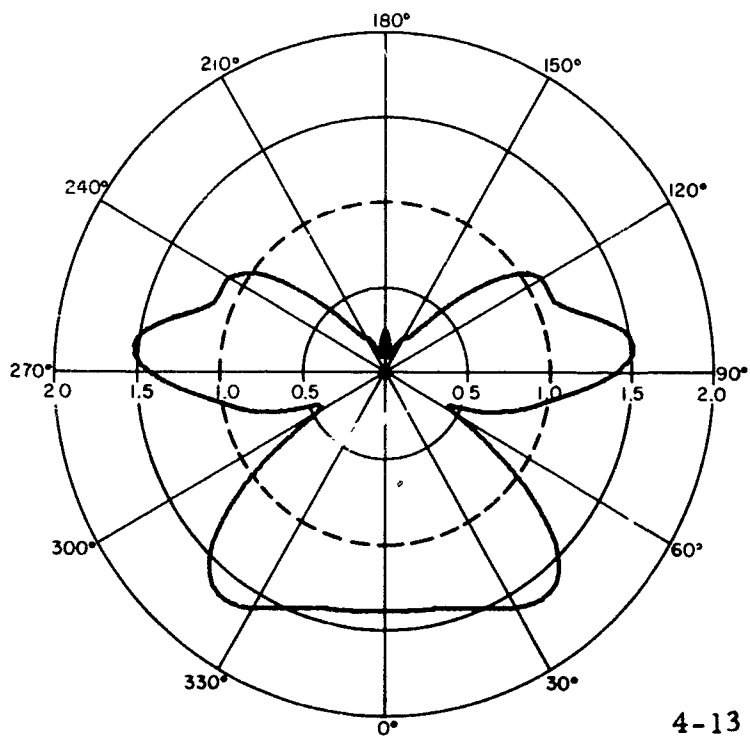
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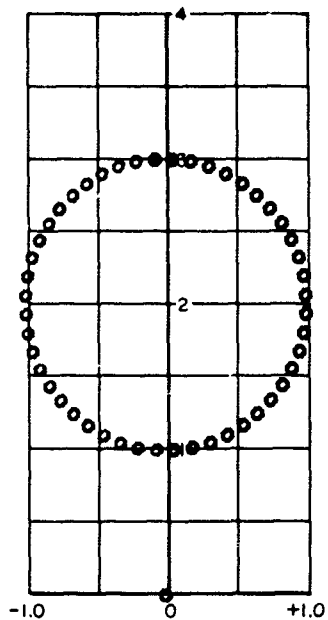


DISTANCE ~ WAVELENGTHS

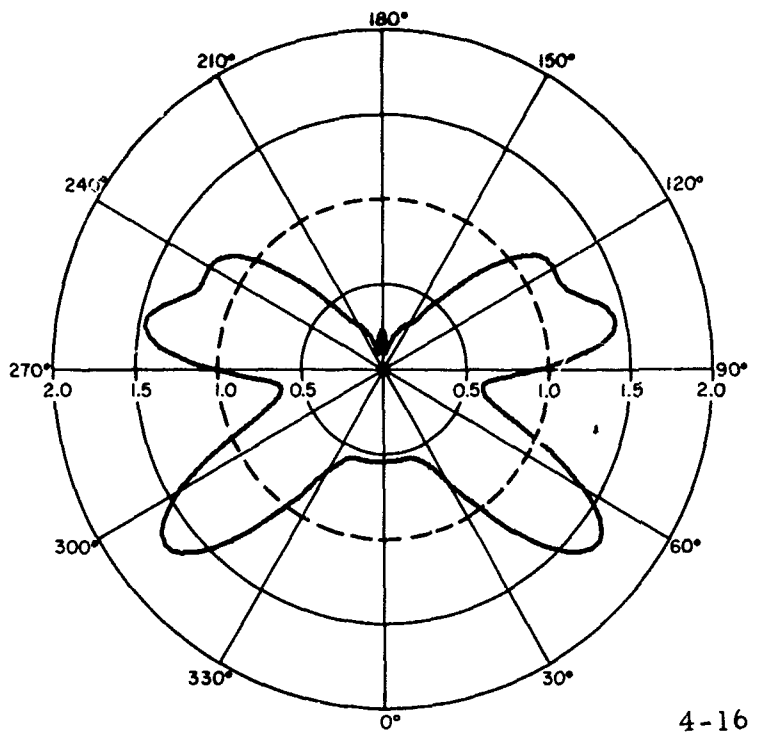


DISTANCE ~ WAVELENGTHS

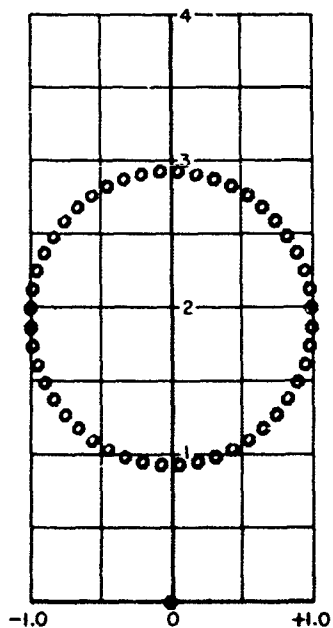




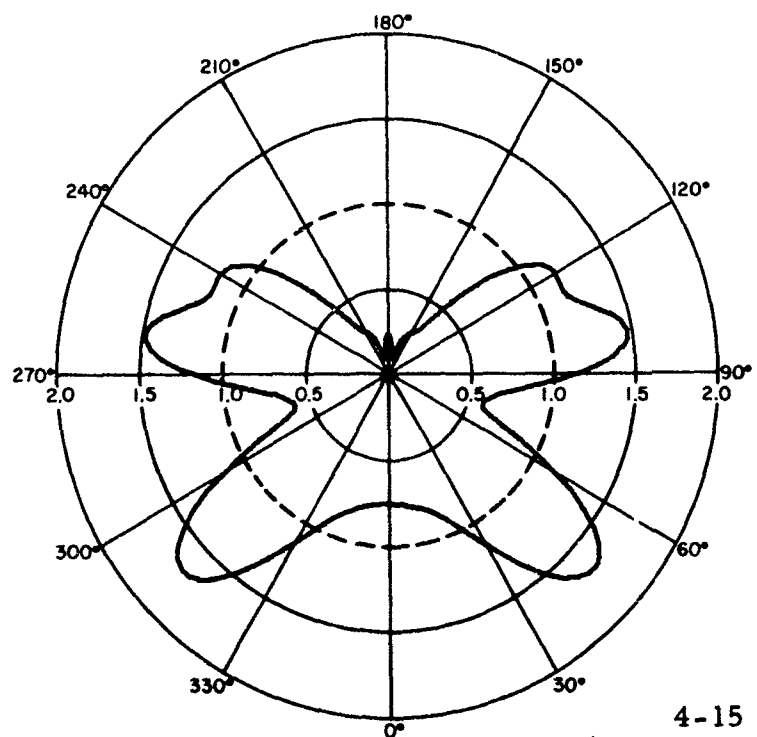
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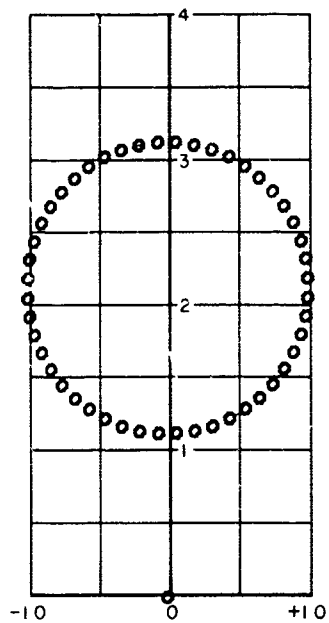
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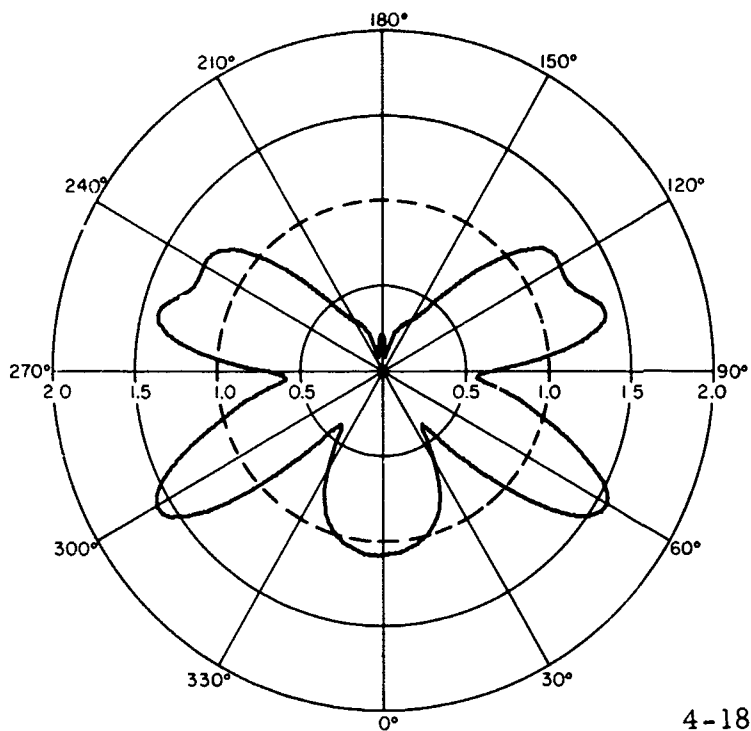
DISTANCE ~ WAVELENGTHS



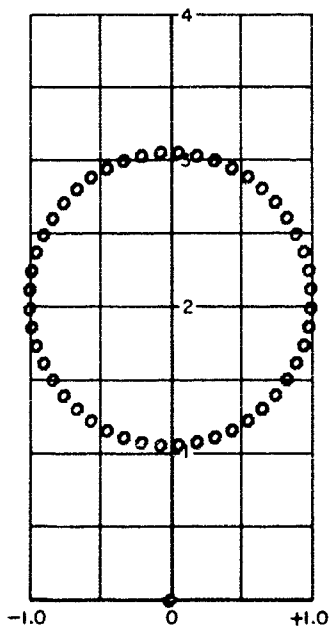
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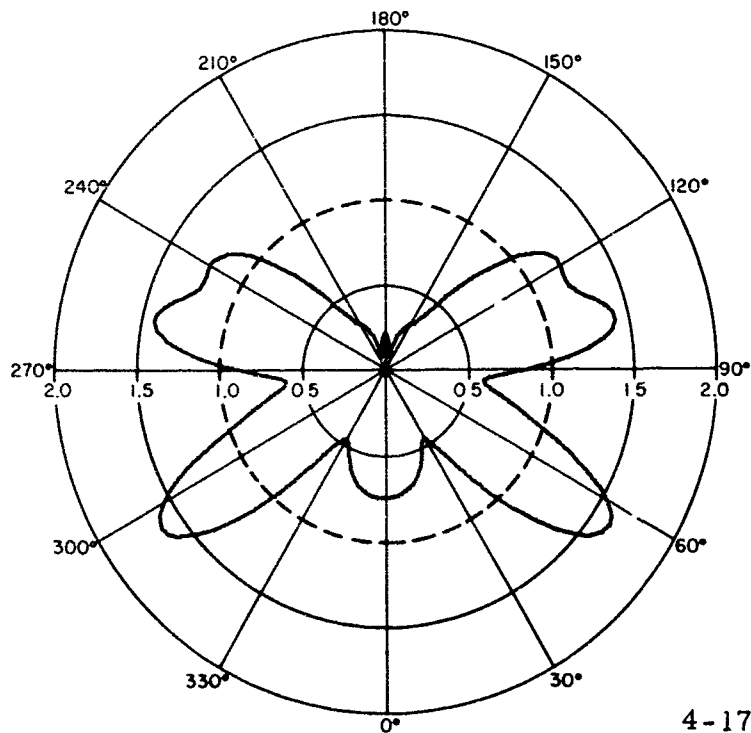
DISTANCE ~ WAVELENGTHS



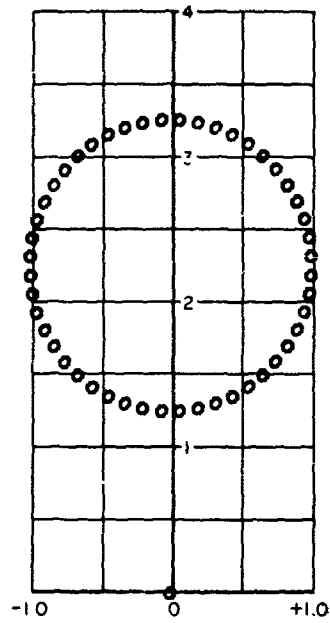
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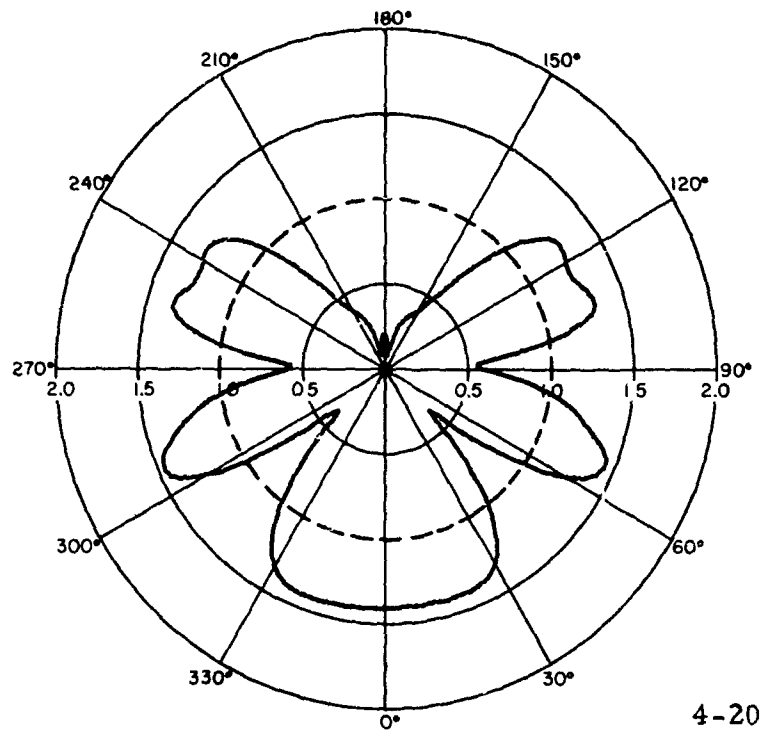
DISTANCE ~ WAVELENGTHS



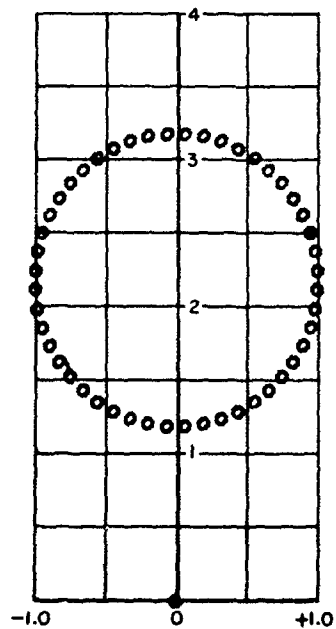
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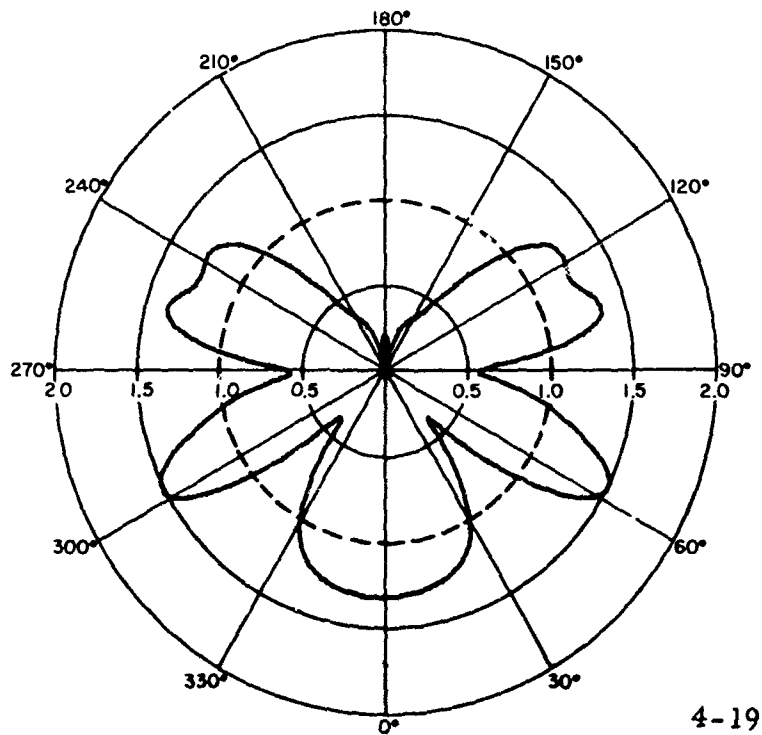
DISTANCE ~ WAVELENGTHS



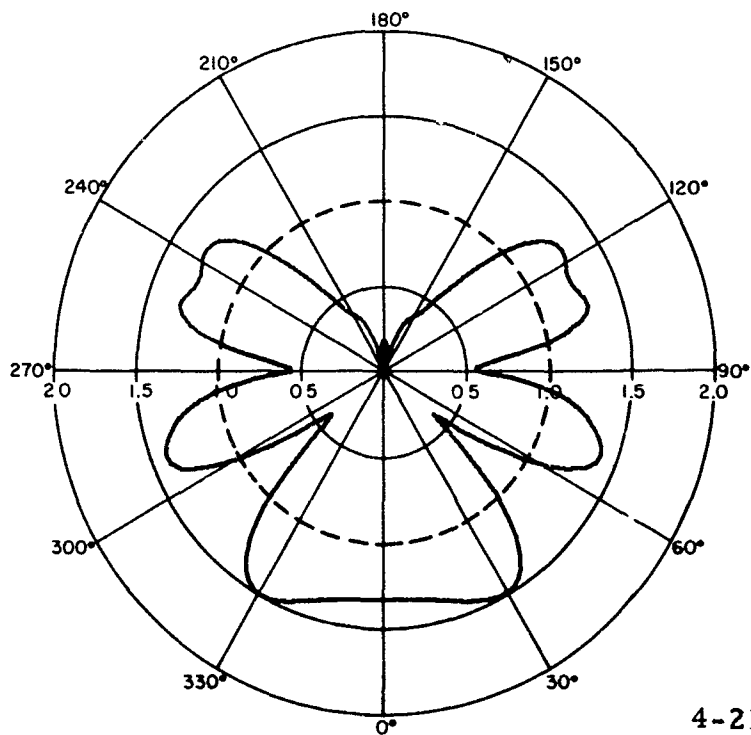
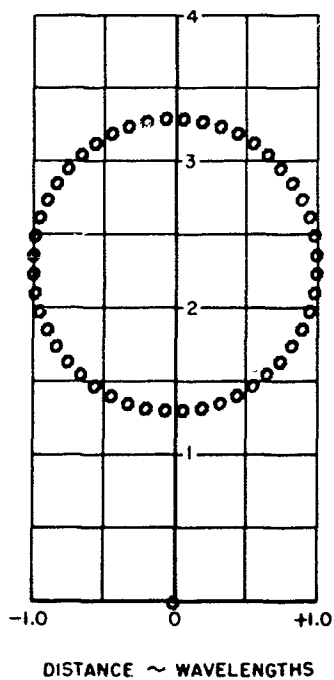
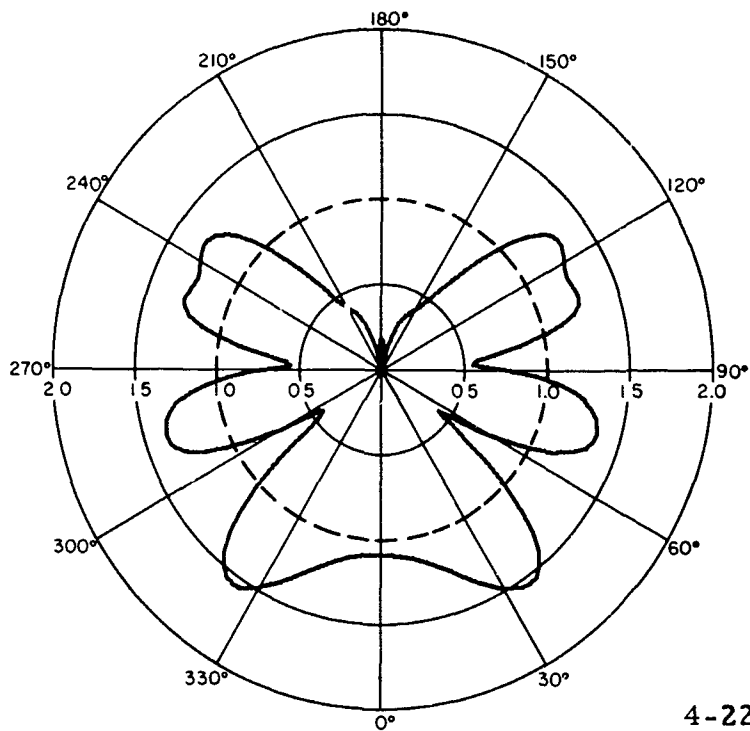
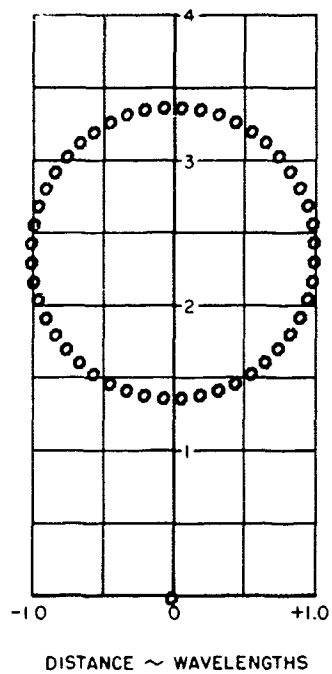
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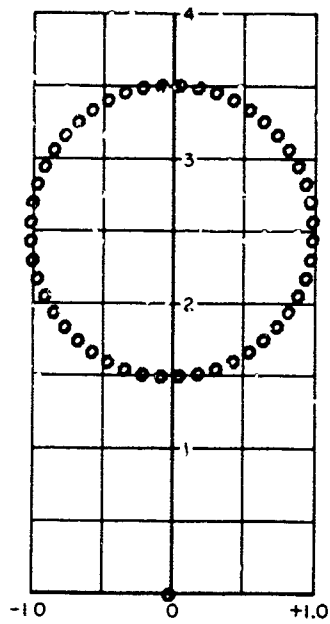
DISTANCE ~ WAVELENGTHS



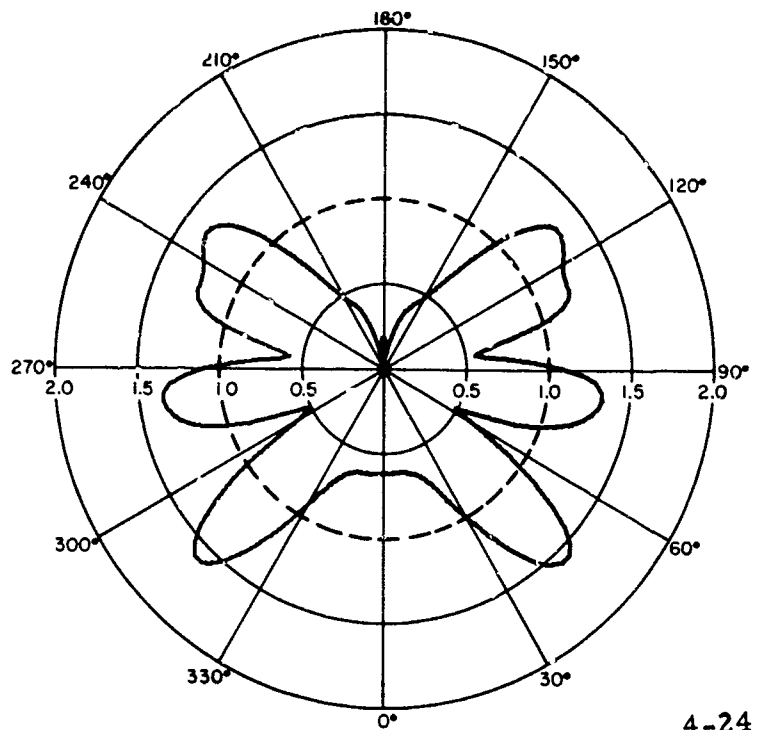
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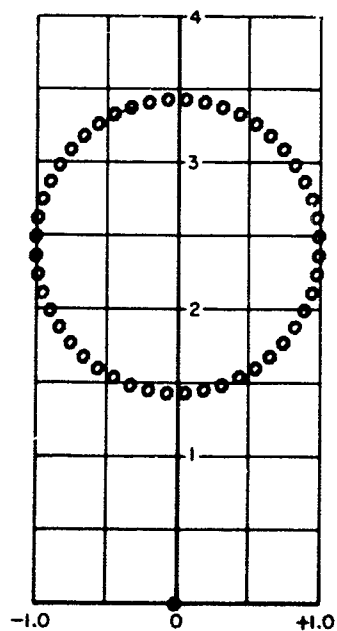




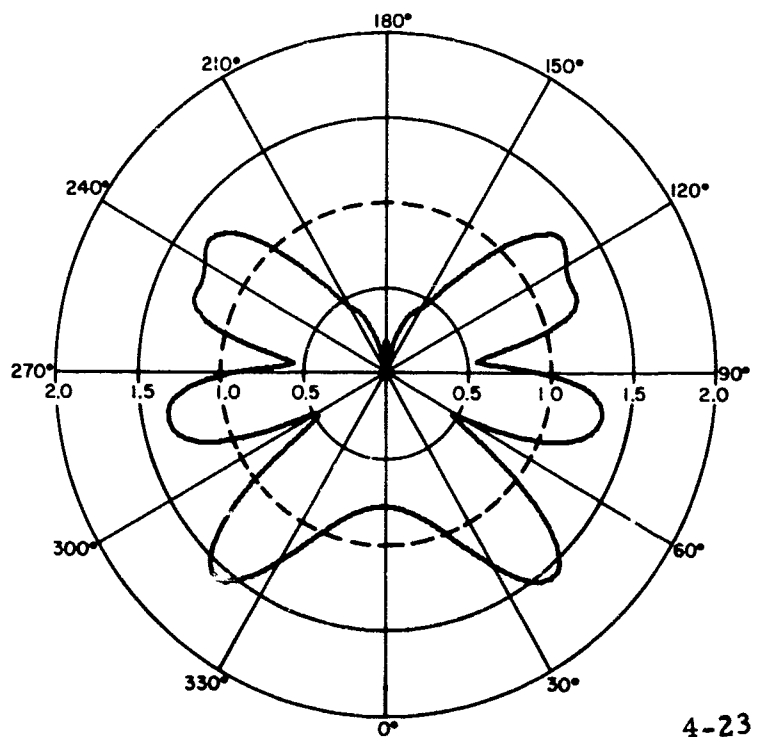
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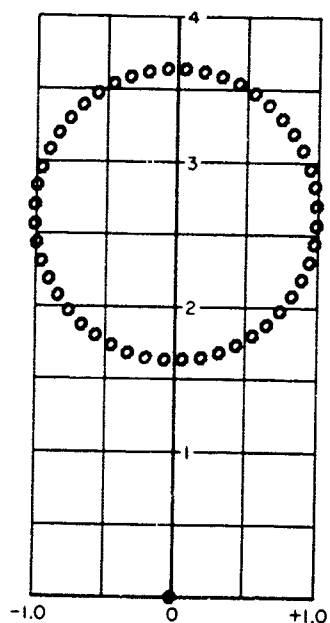
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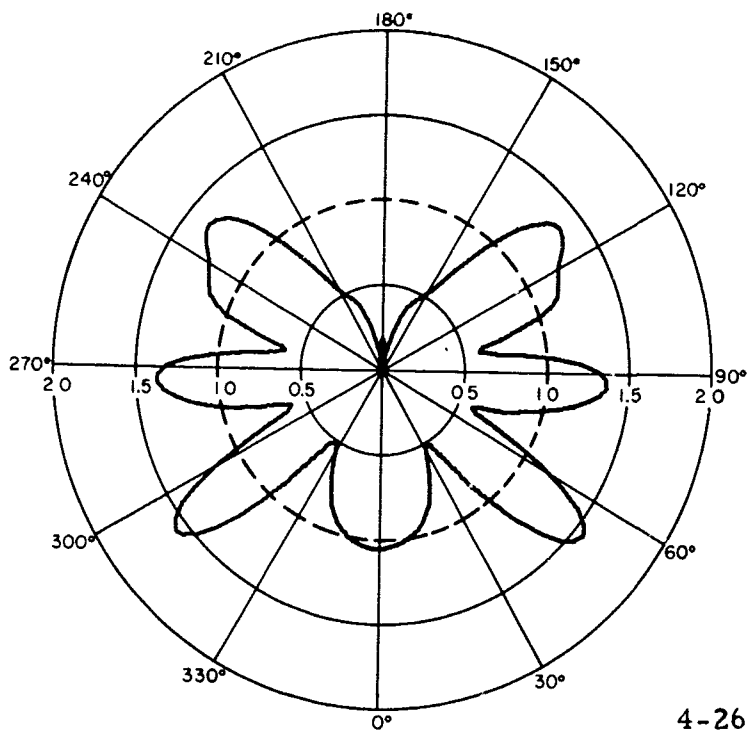
DISTANCE ~ WAVELENGTHS



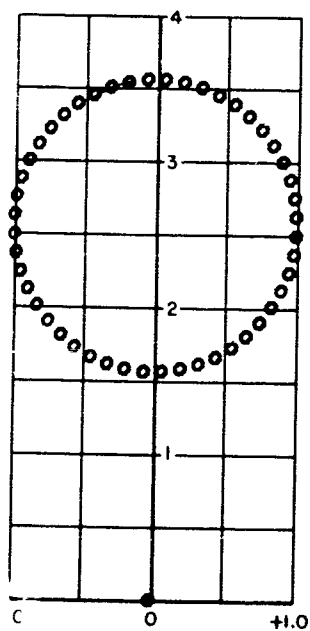
4-23



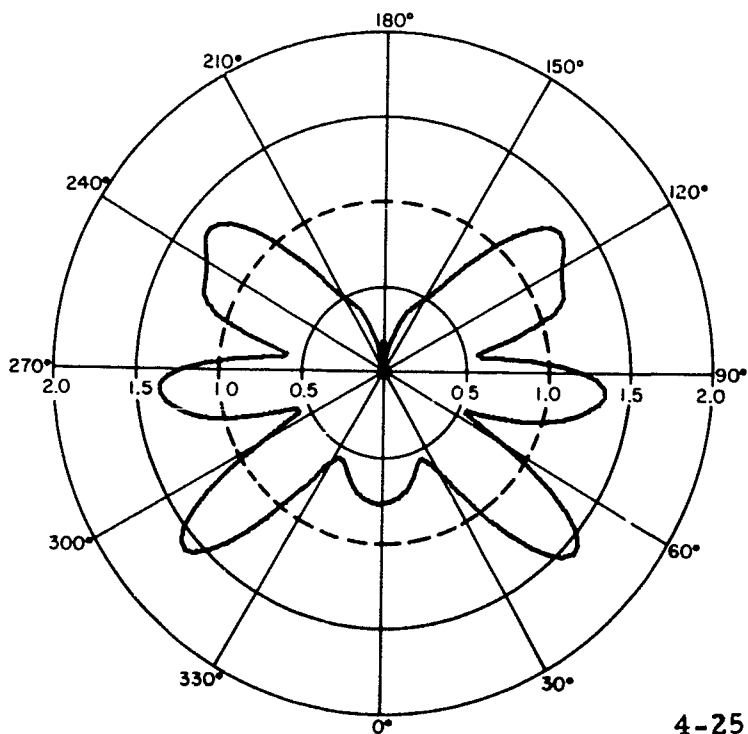
DISTANCE ~ WAVELENGTHS



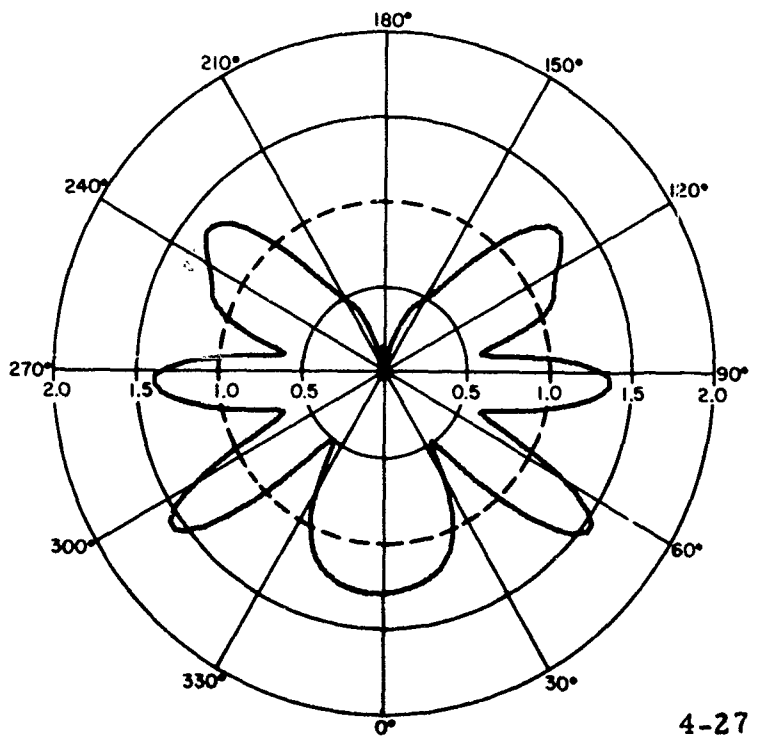
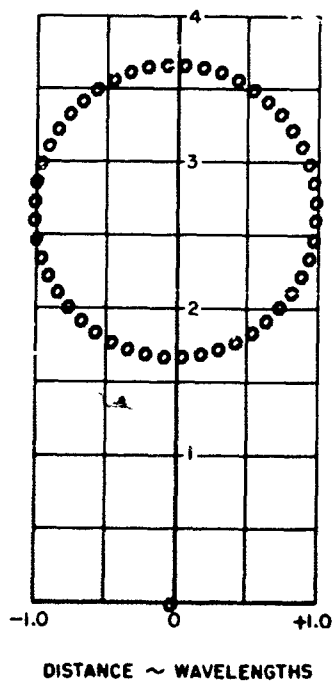
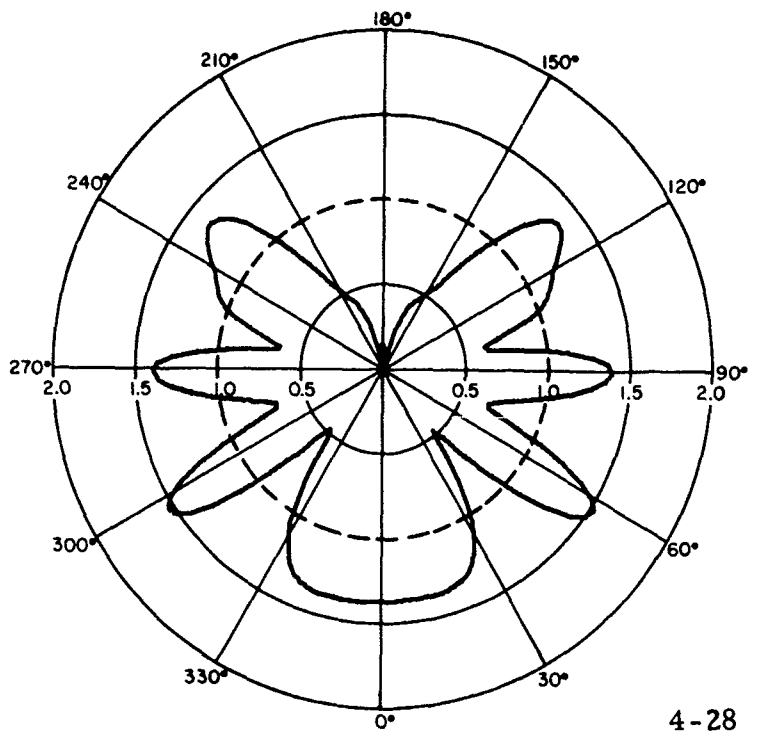
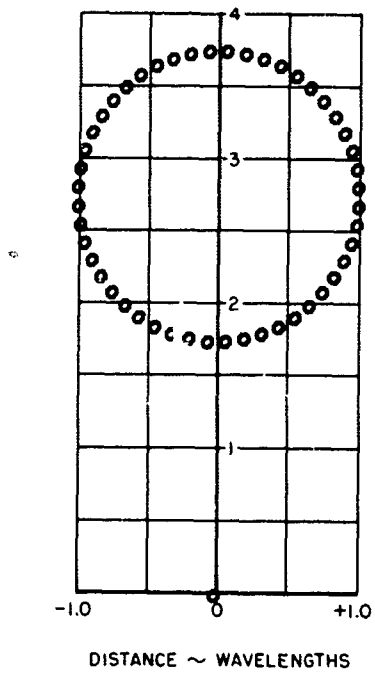
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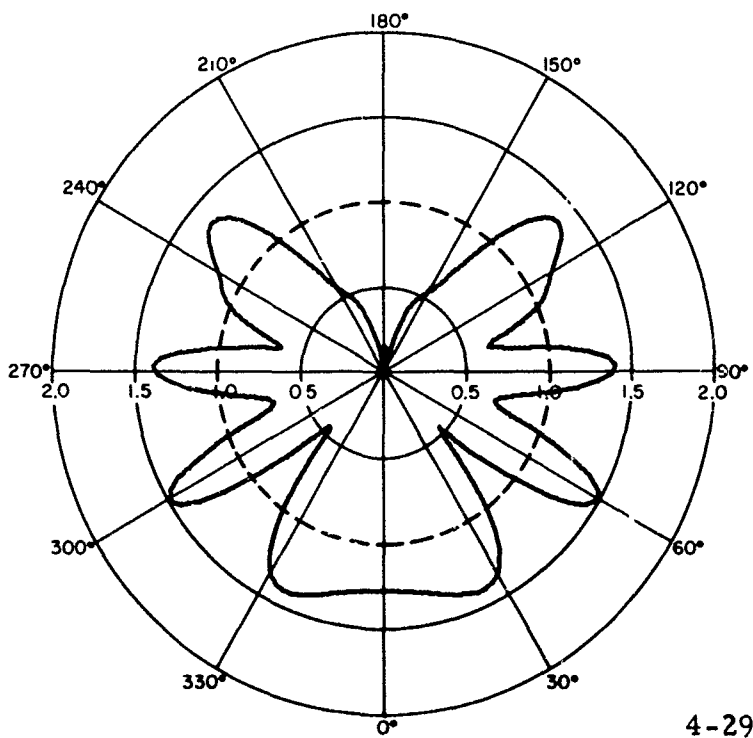
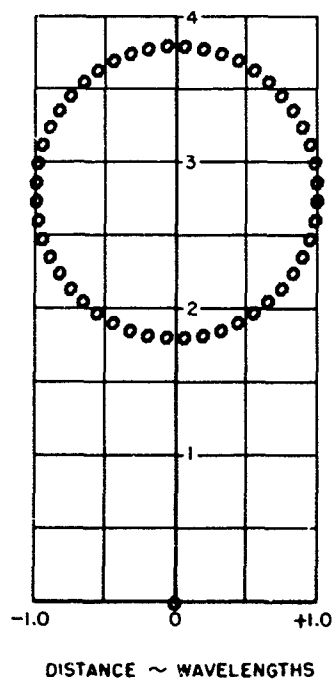
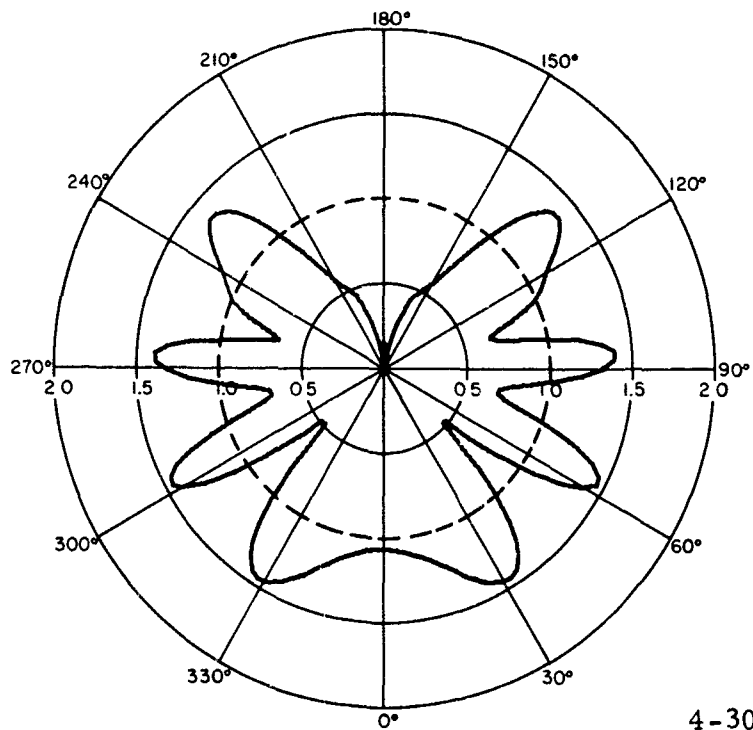
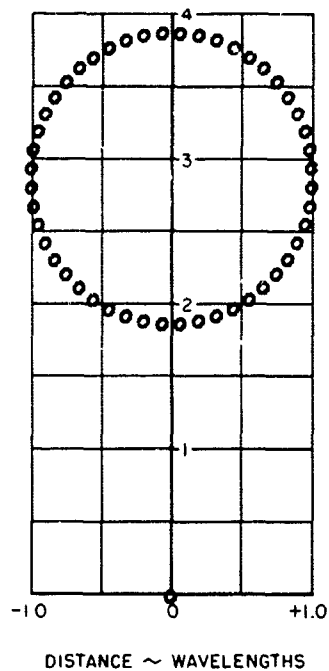


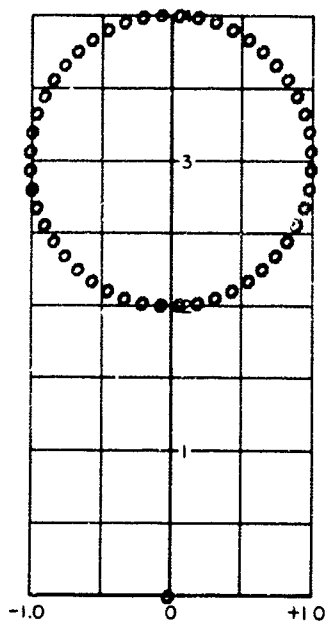
DISTANCE ~ WAVELENGTHS



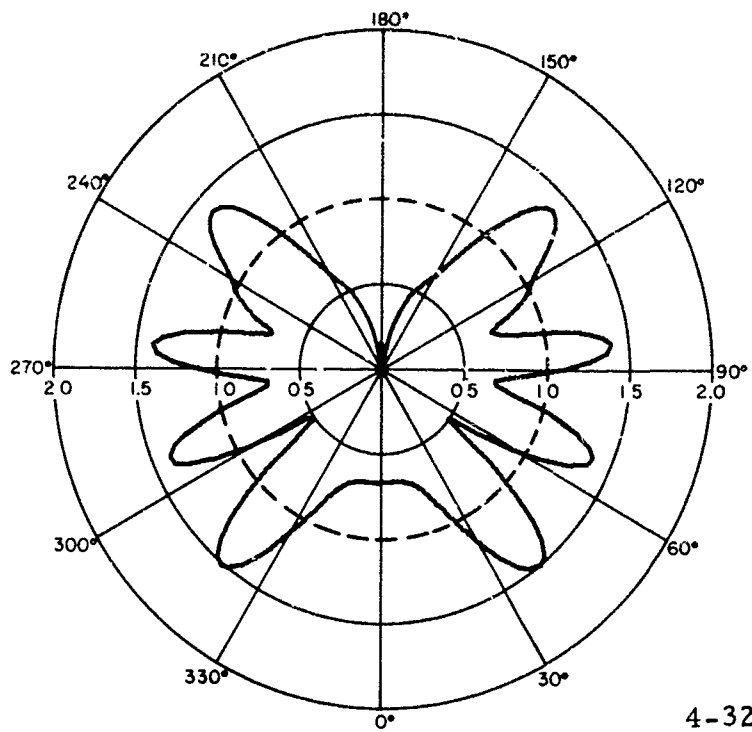
4-25



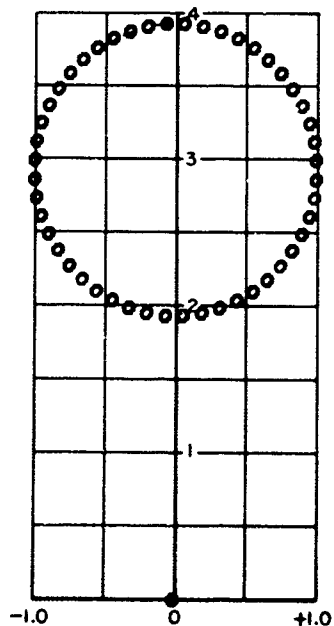




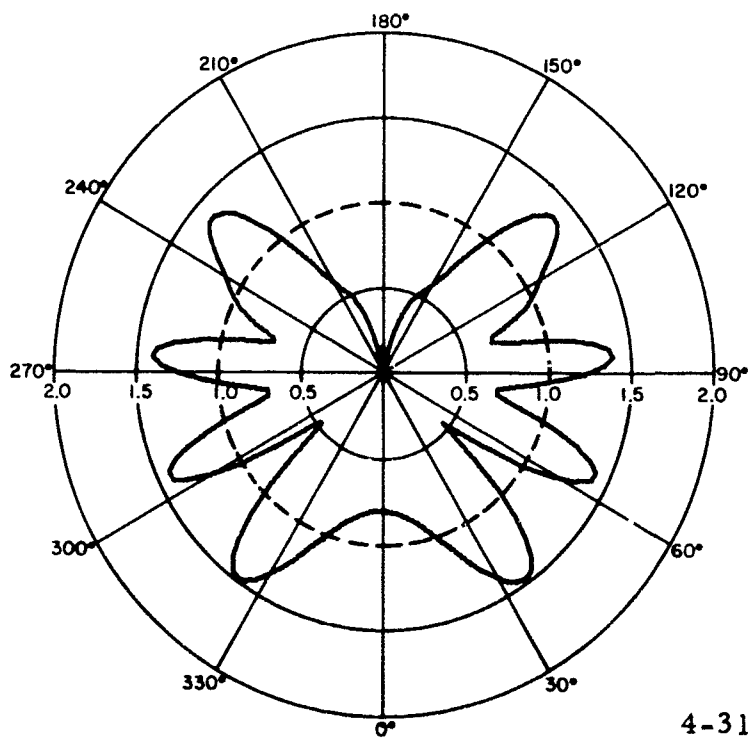
DISTANCE ~ WAVELENGTHS



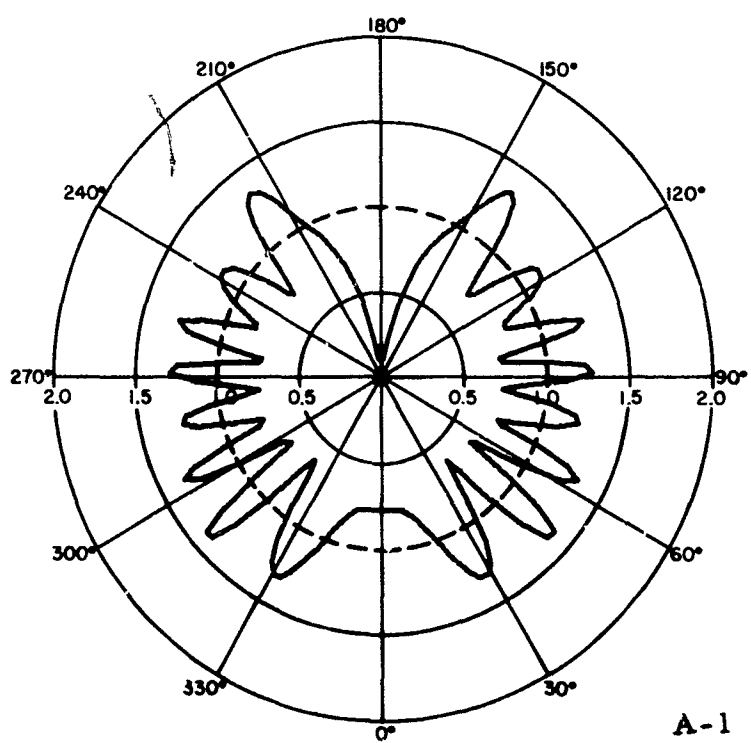
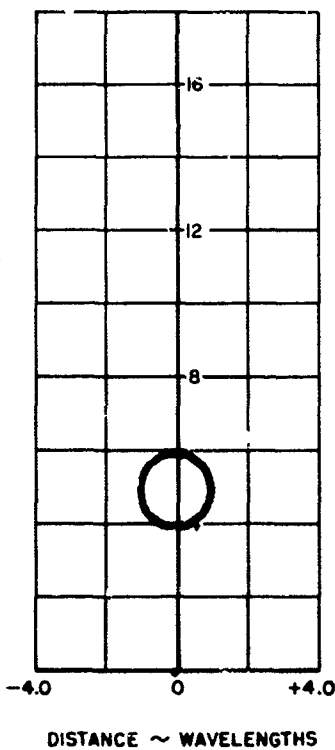
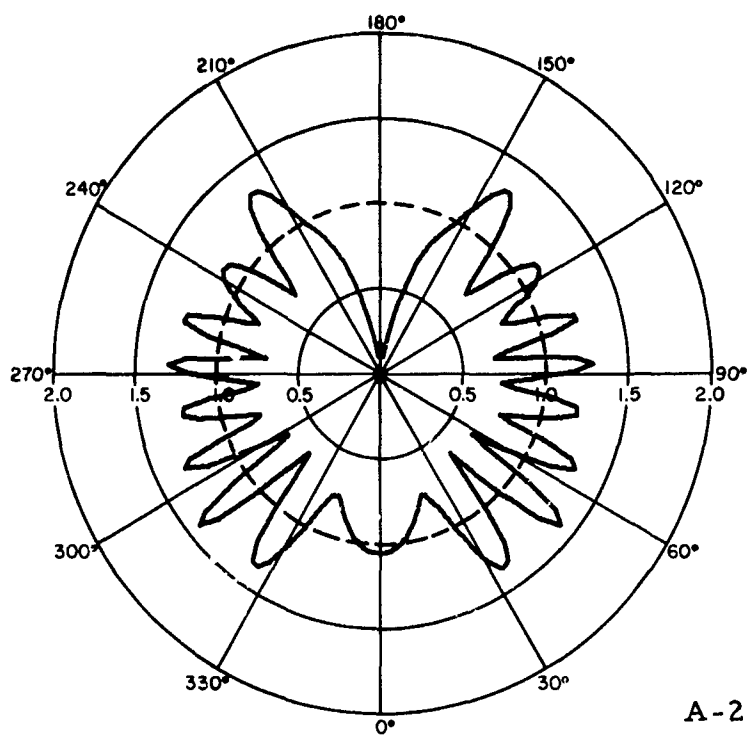
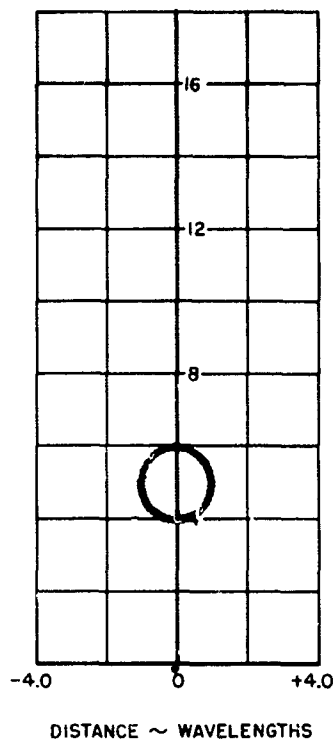
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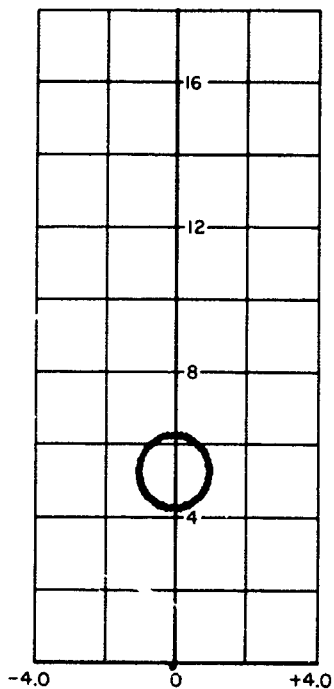


DISTANCE ~ WAVELENGTHS

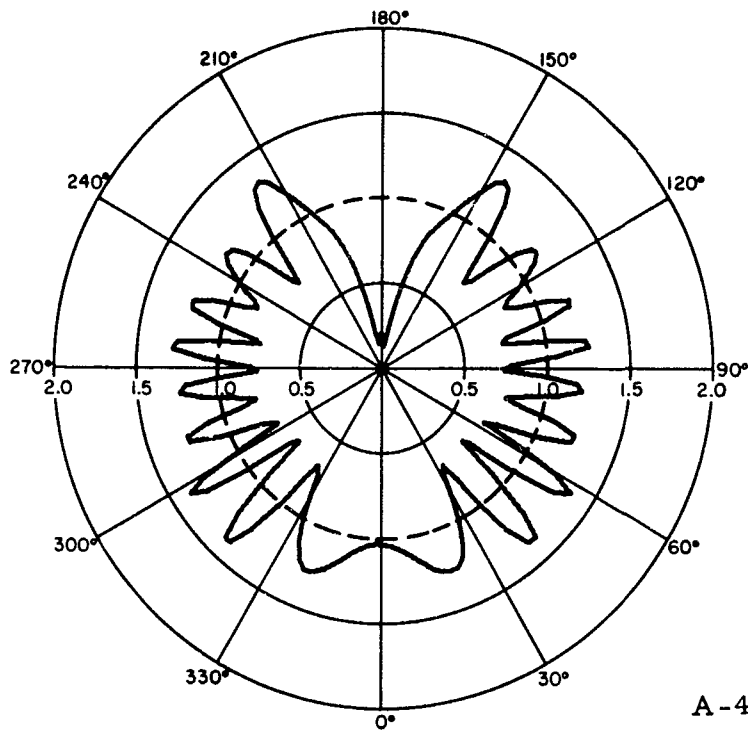


4-31

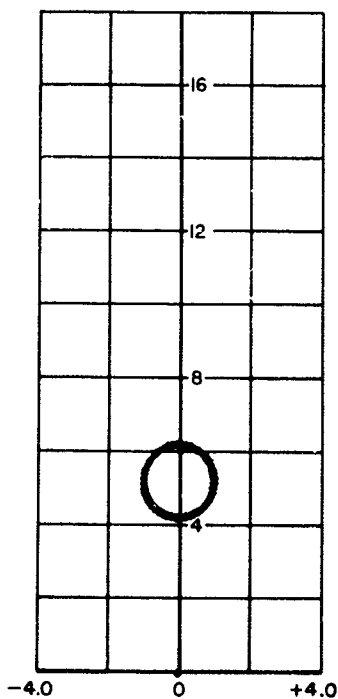




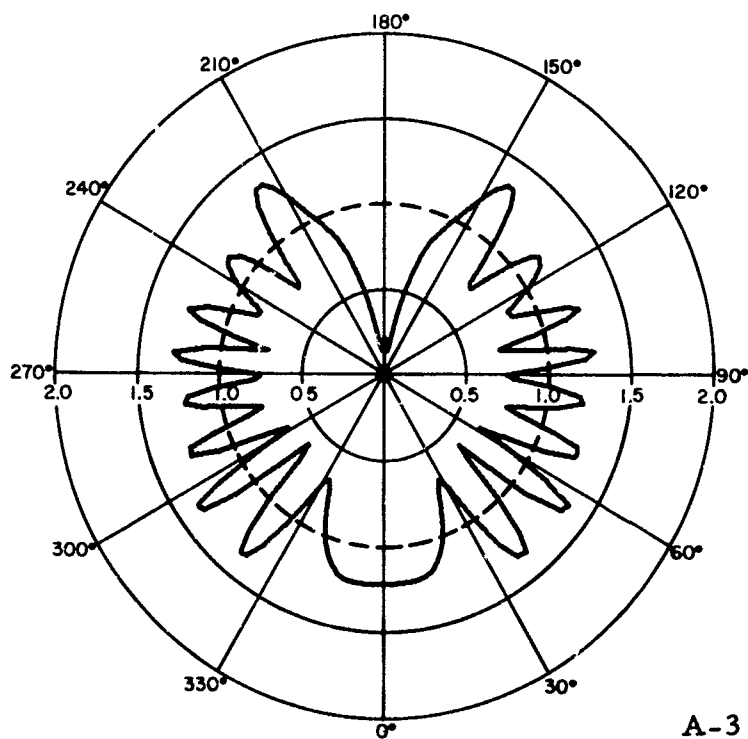
DISTANCE ~ WAVELENGTHS



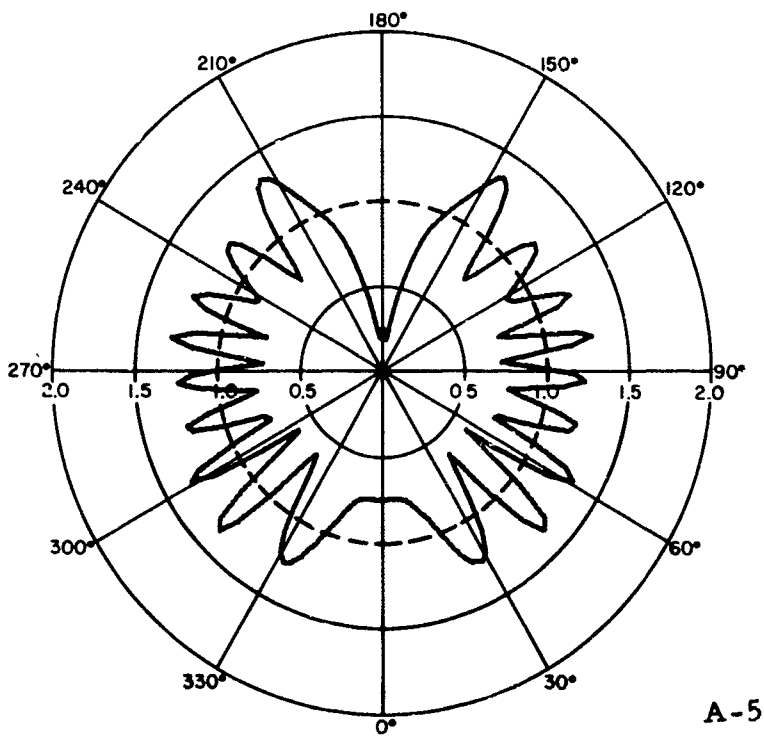
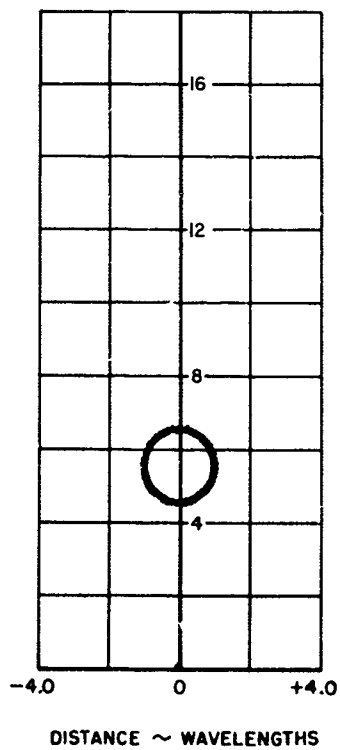
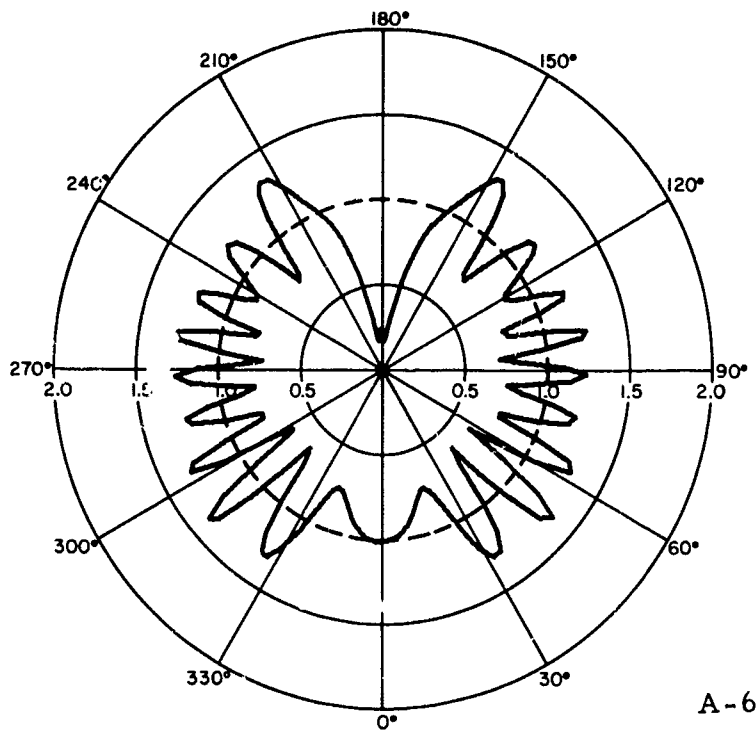
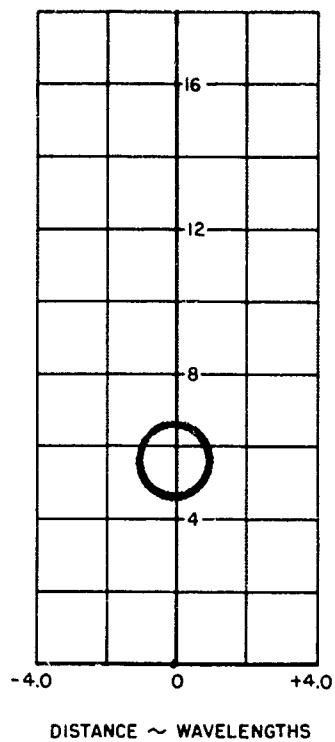
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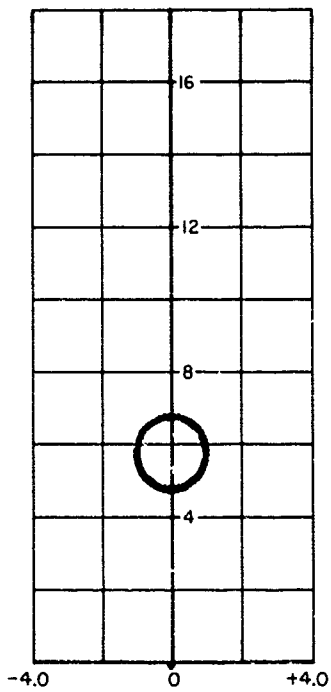
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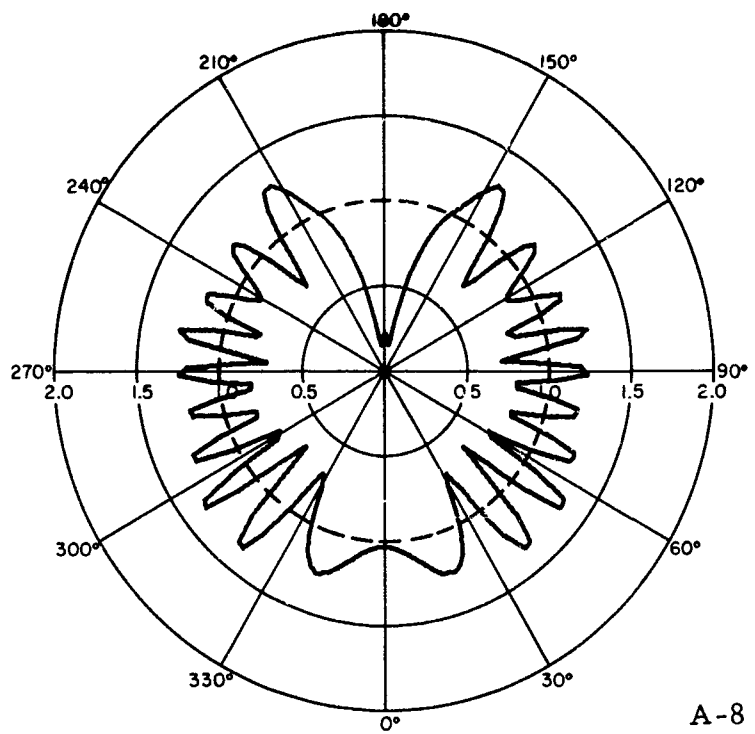
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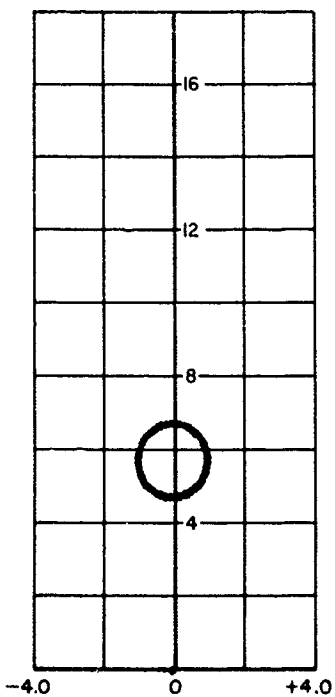




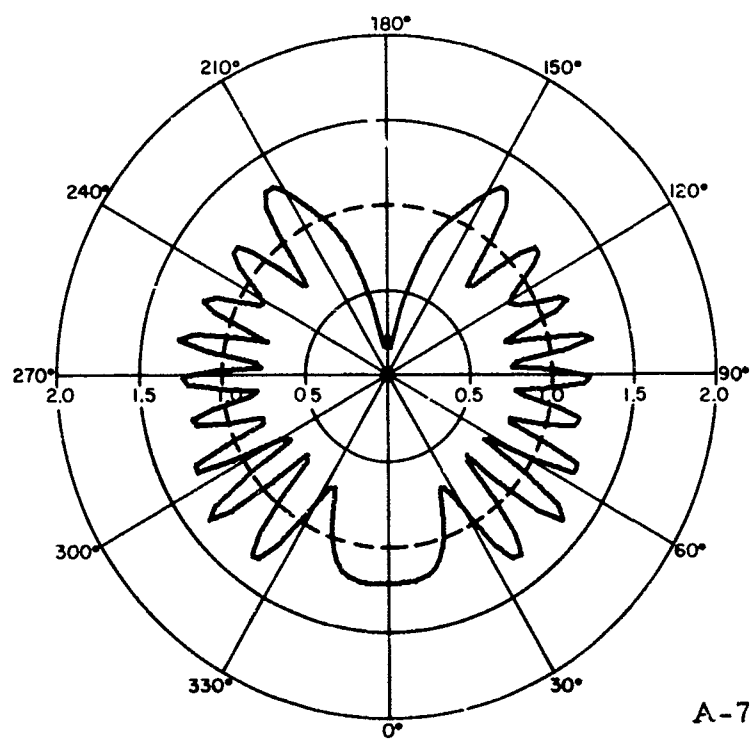
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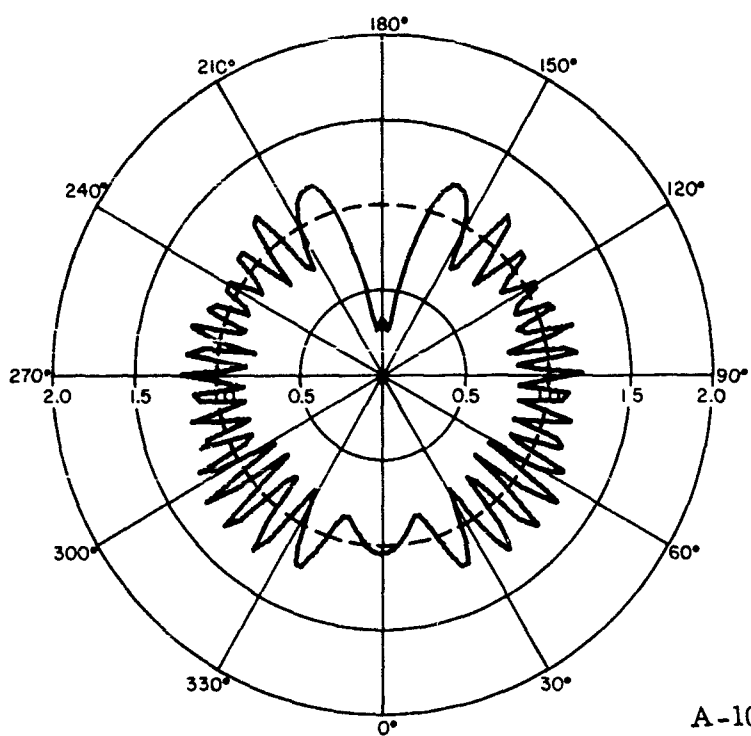
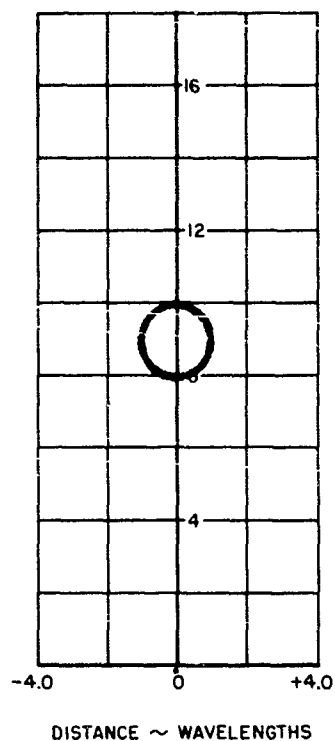
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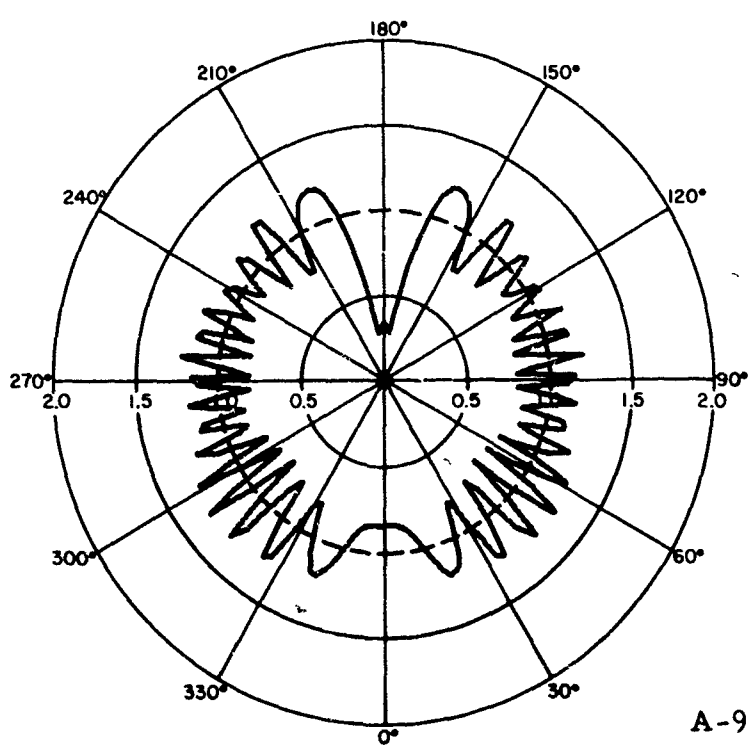
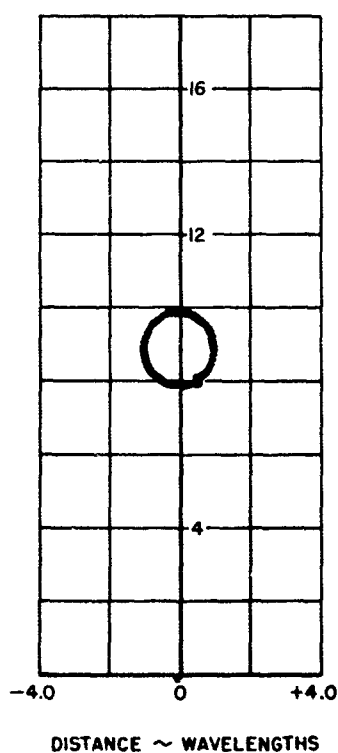
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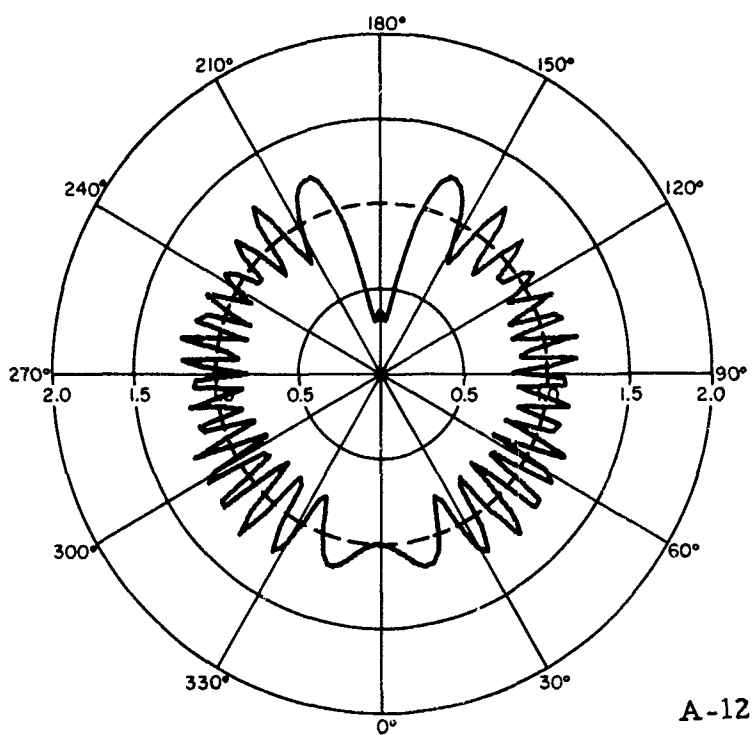
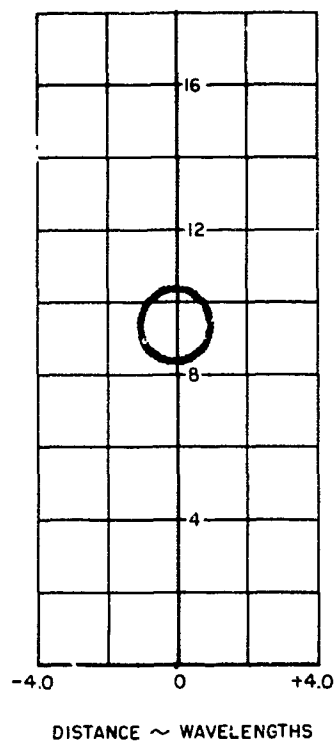
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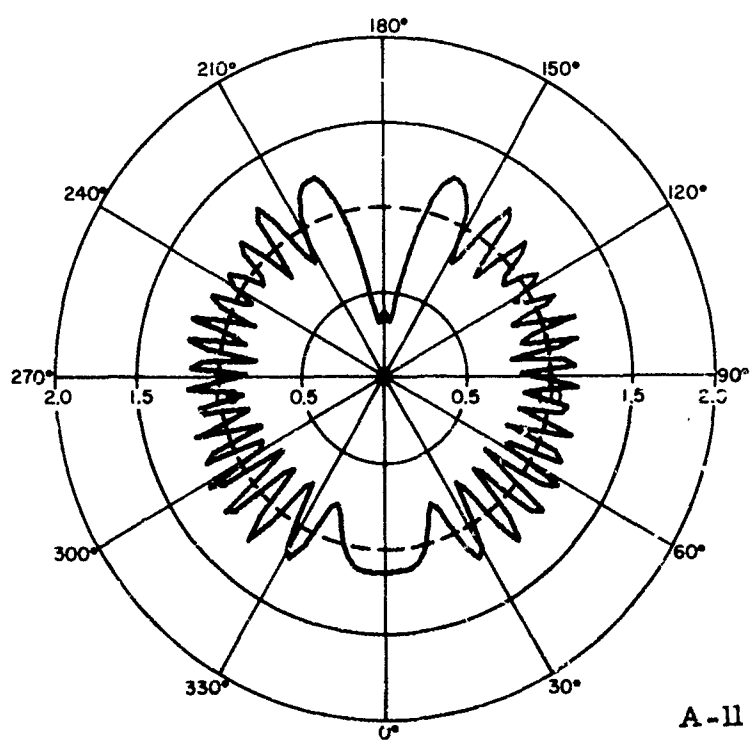
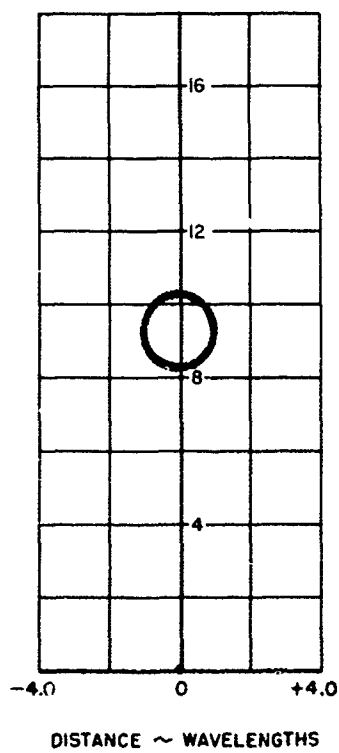
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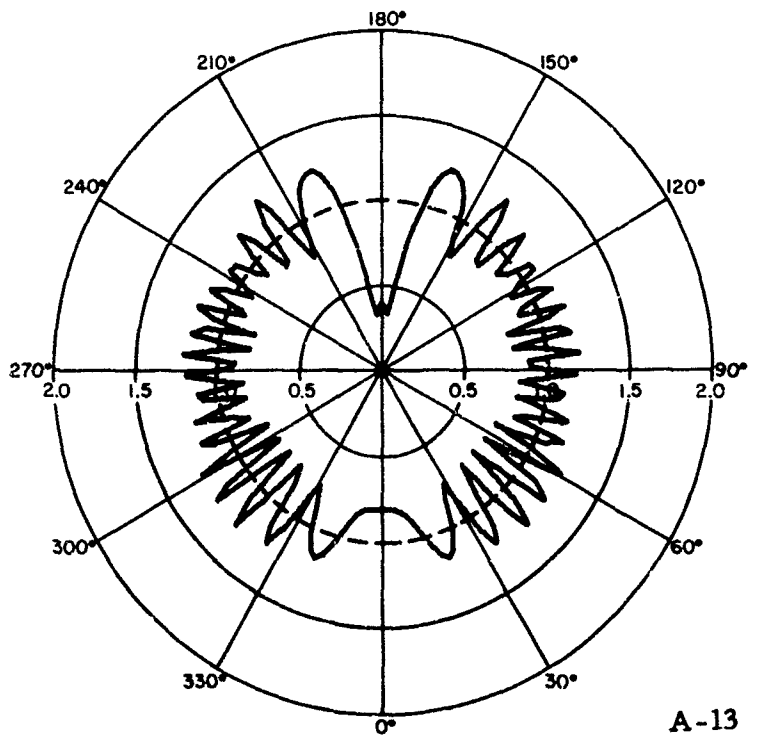
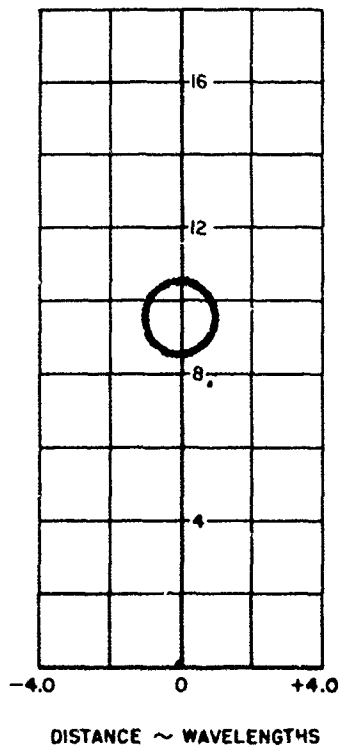
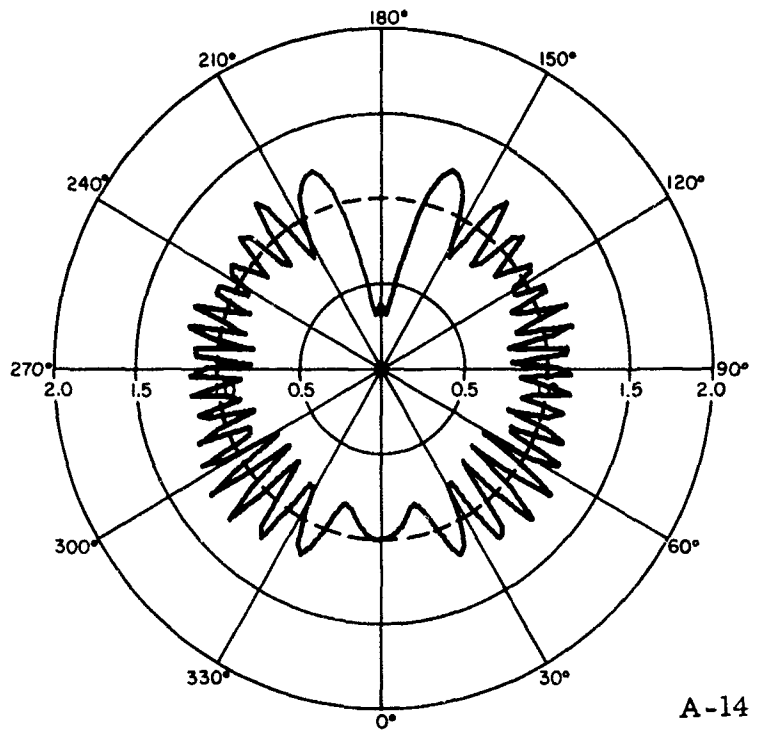
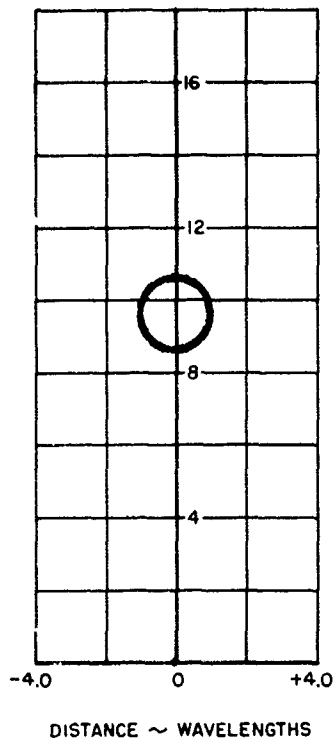
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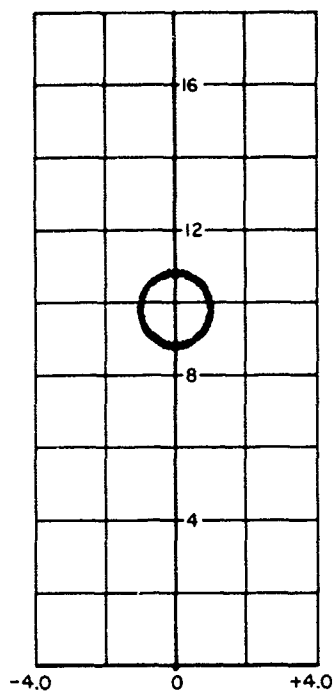


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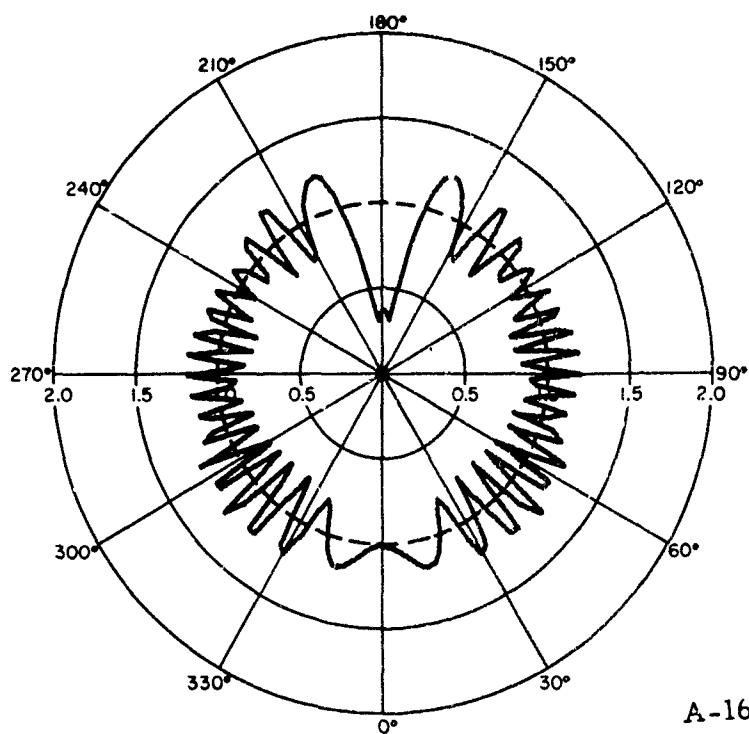


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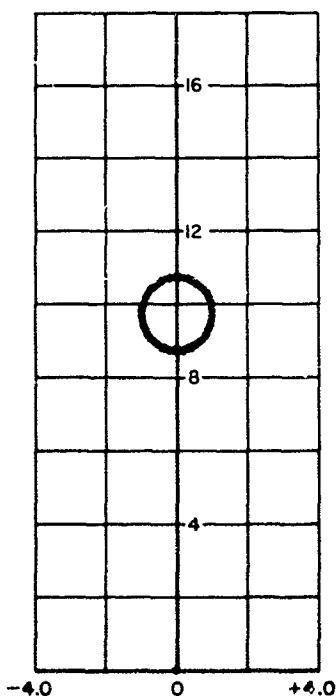




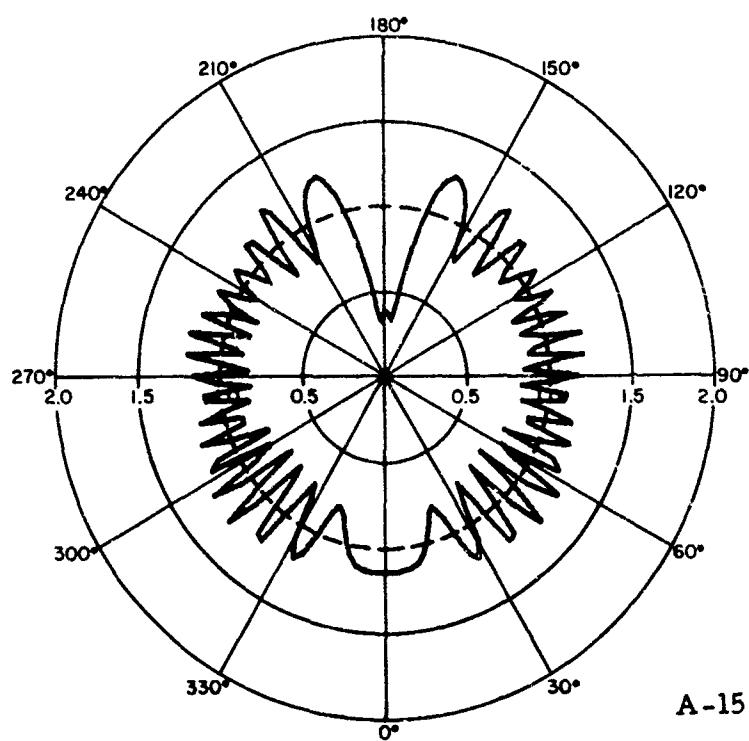
DISTANCE ~ WAVELENGTHS



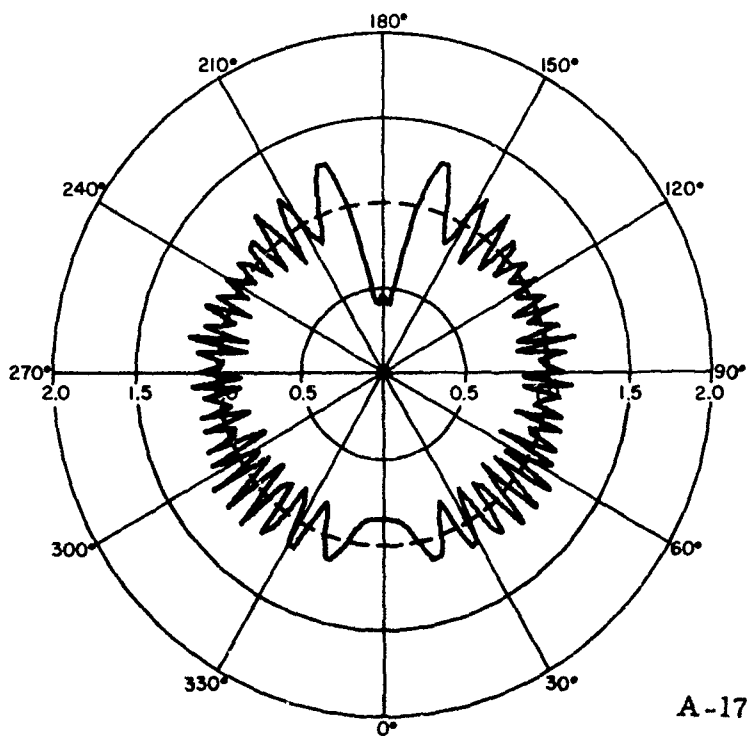
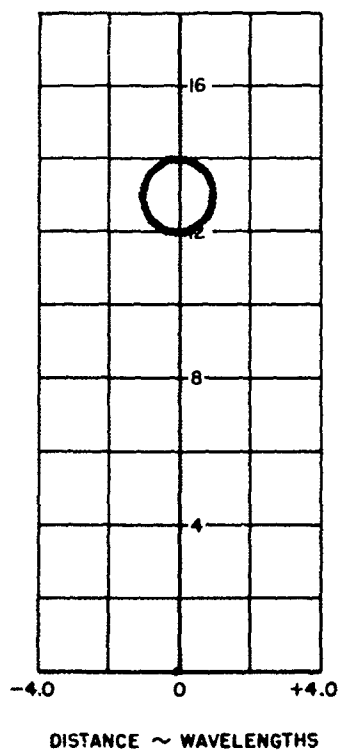
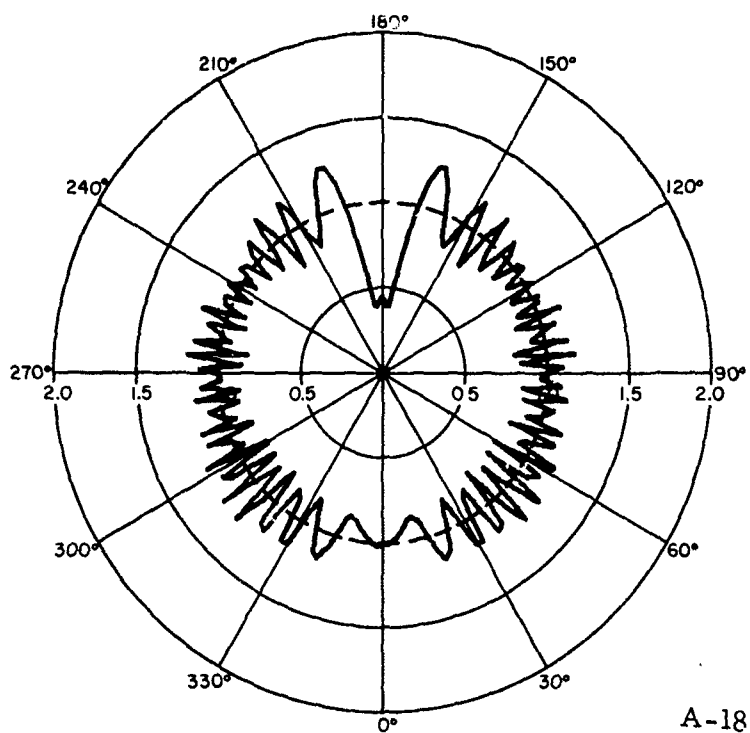
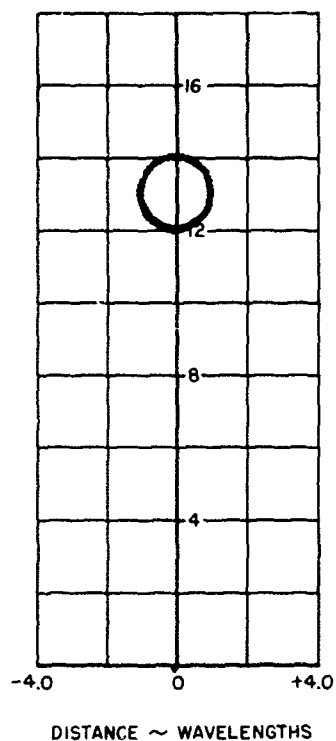
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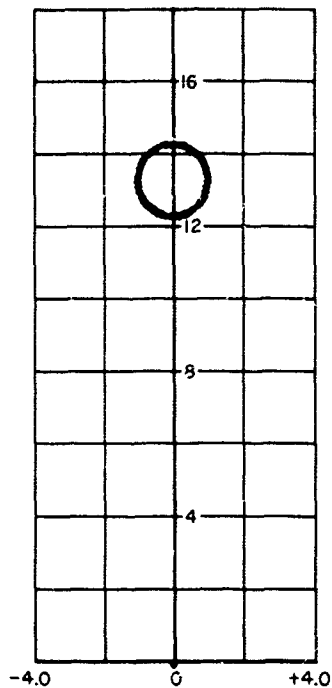


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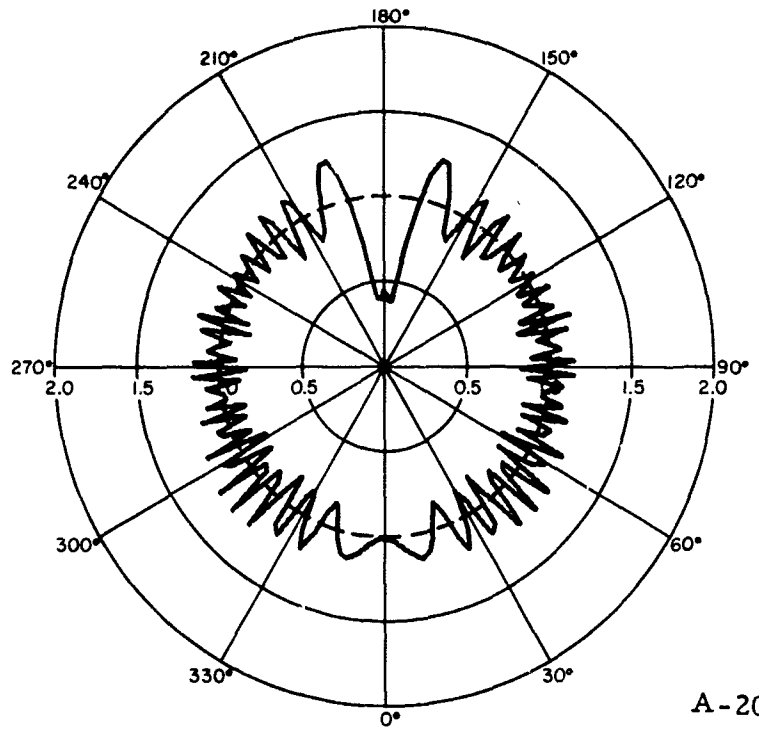


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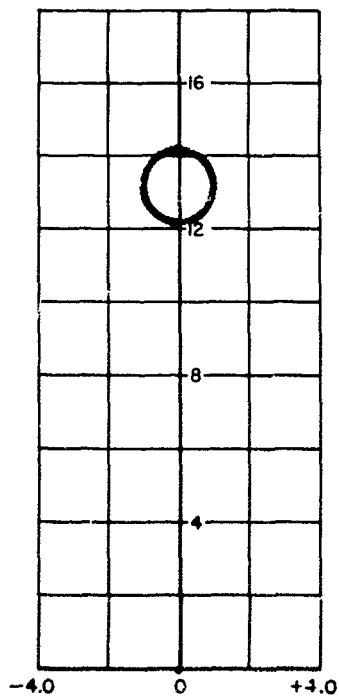




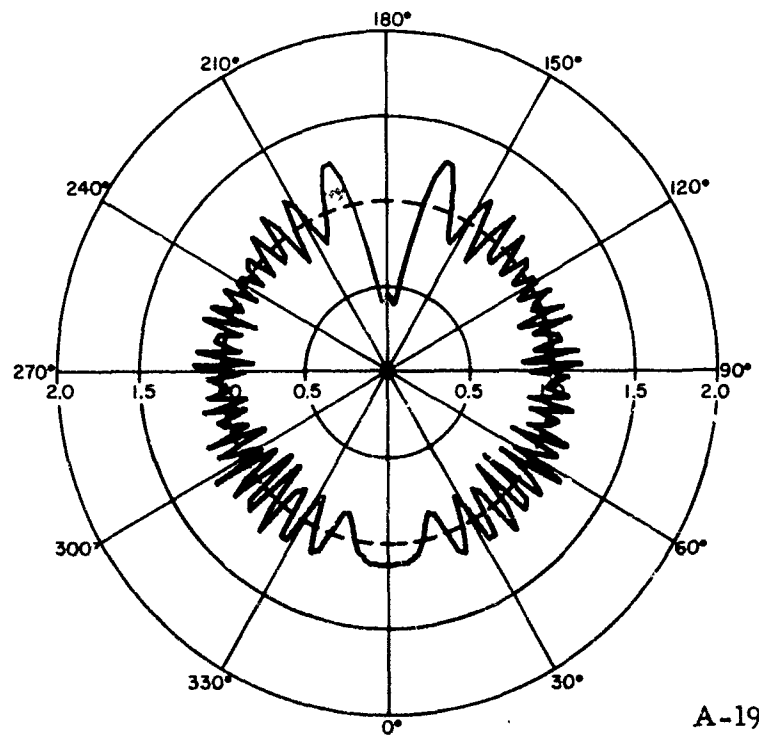
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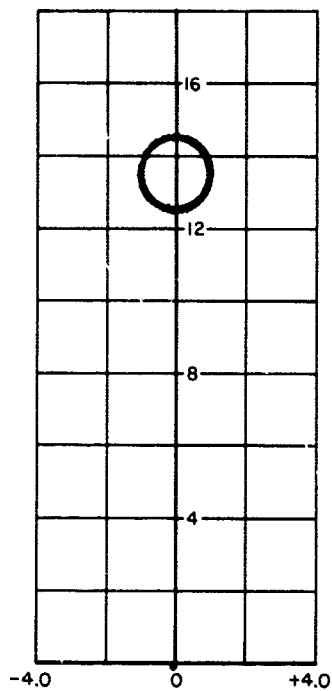
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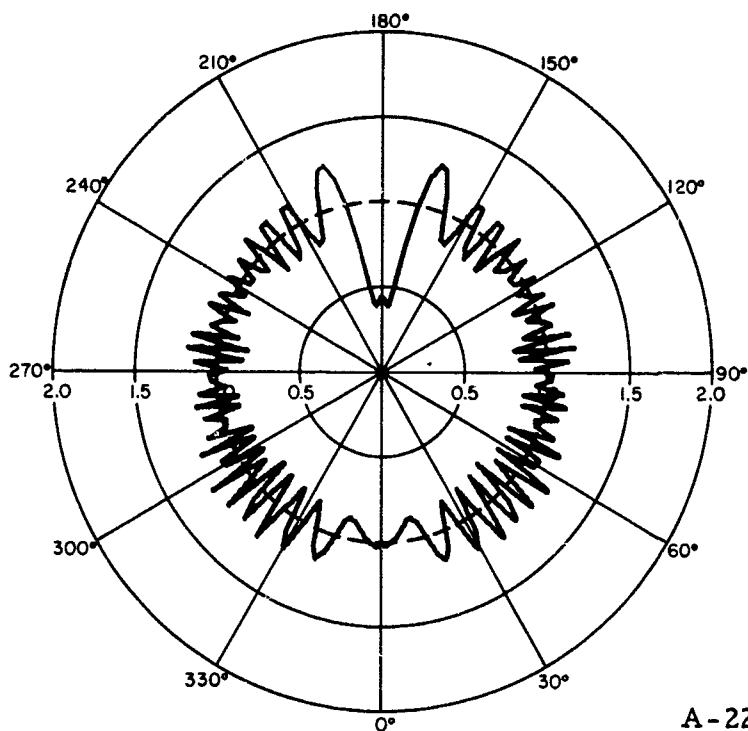
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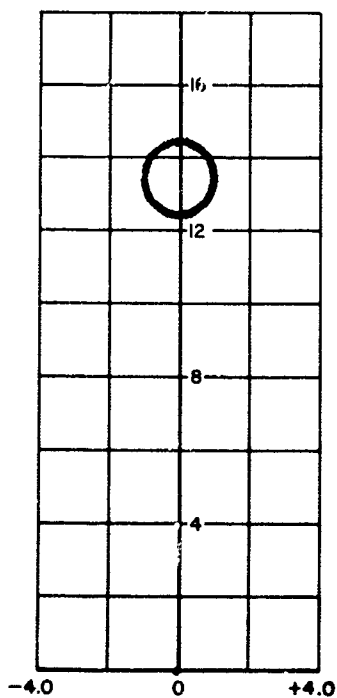
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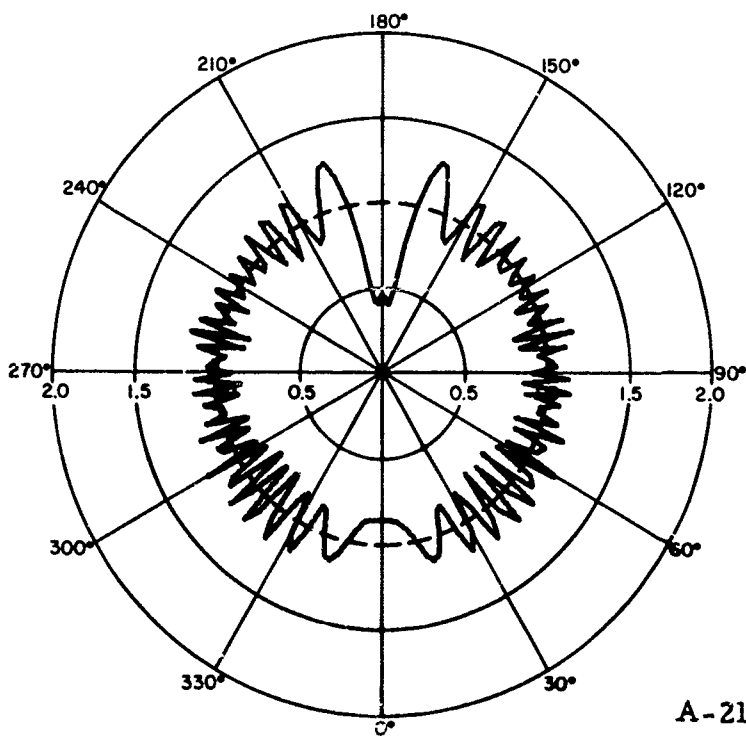
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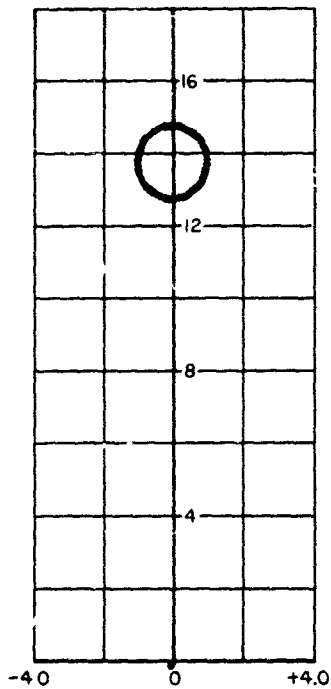


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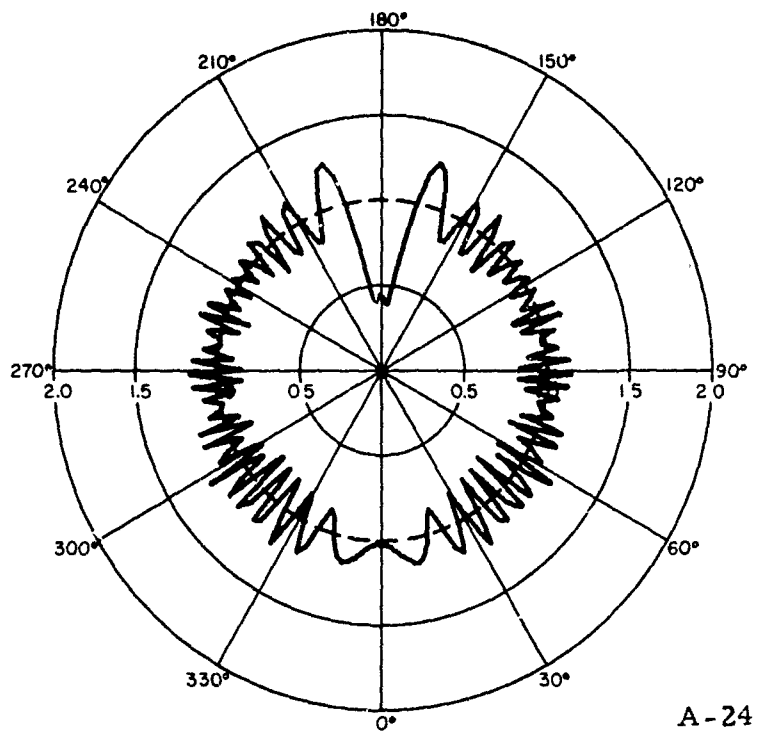


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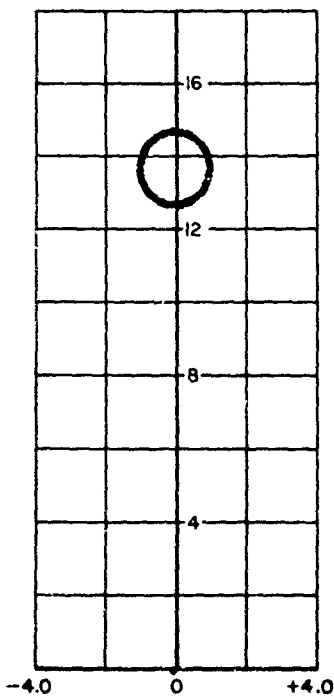




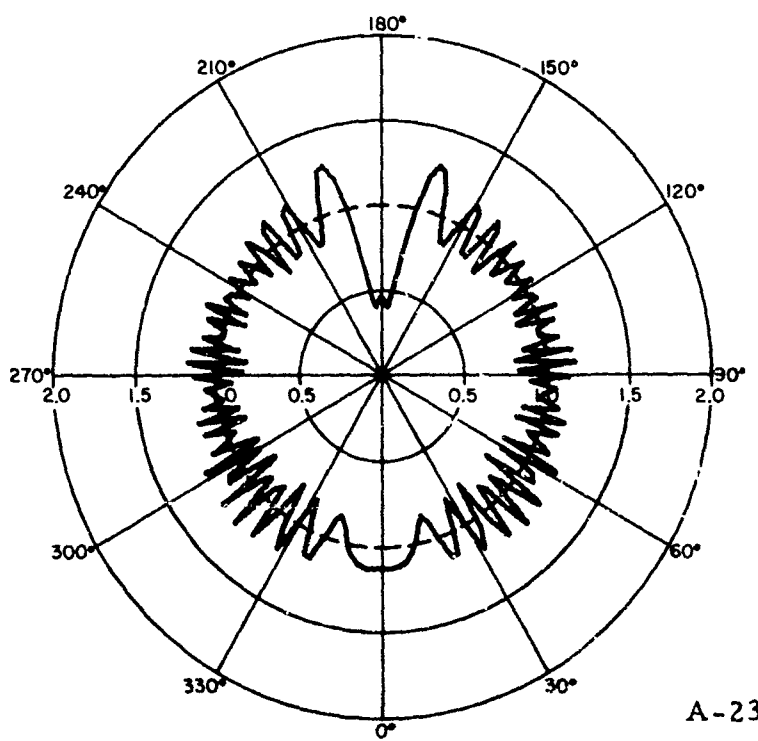
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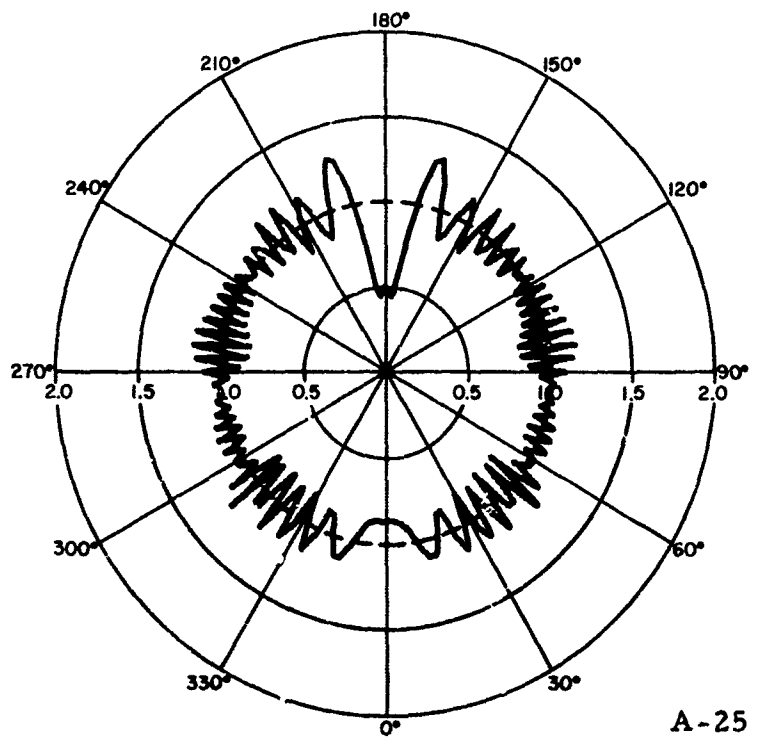
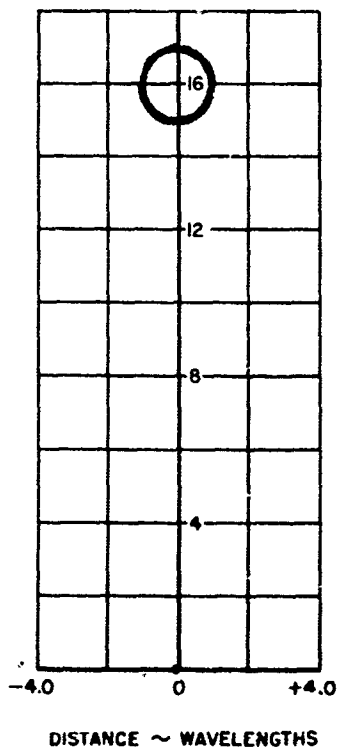
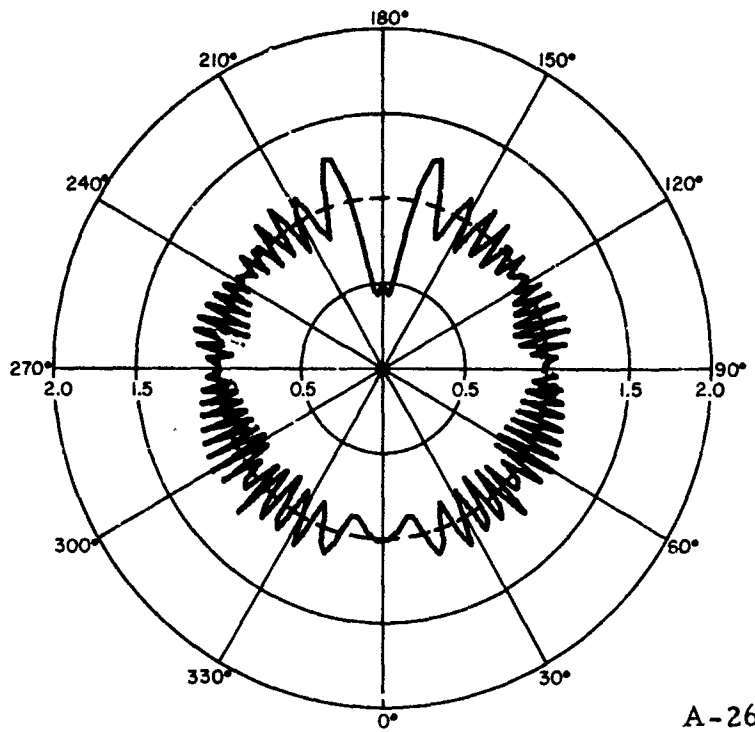
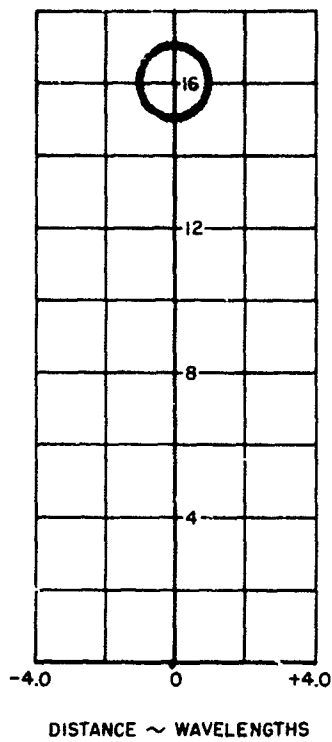
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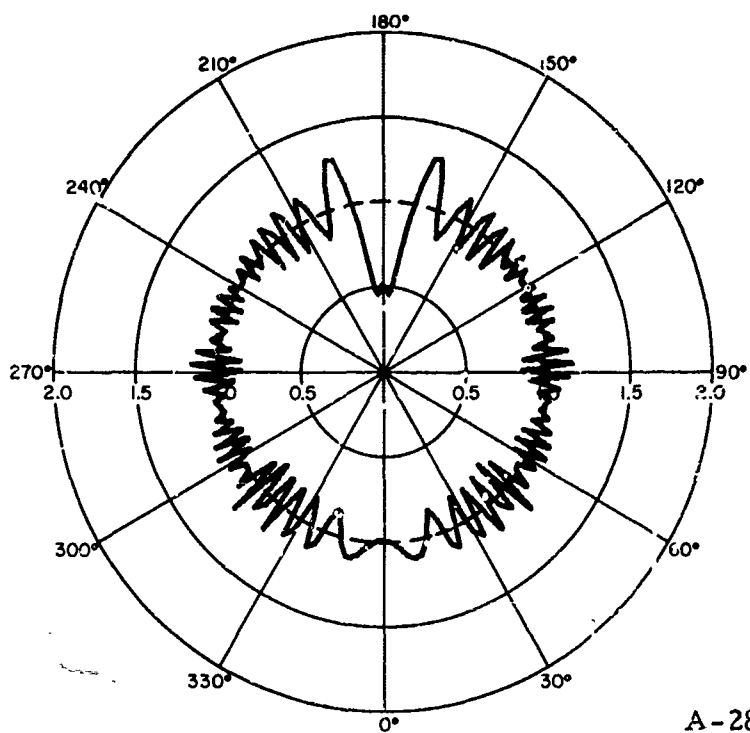
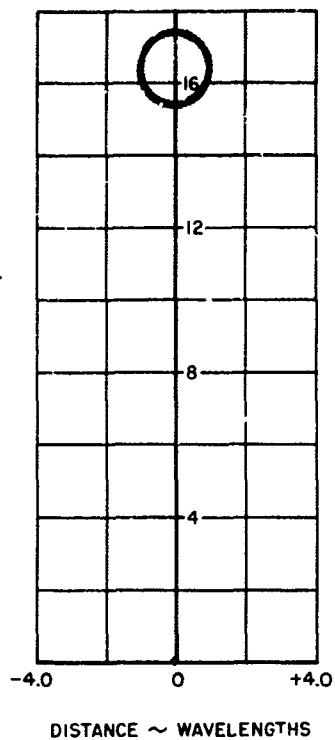


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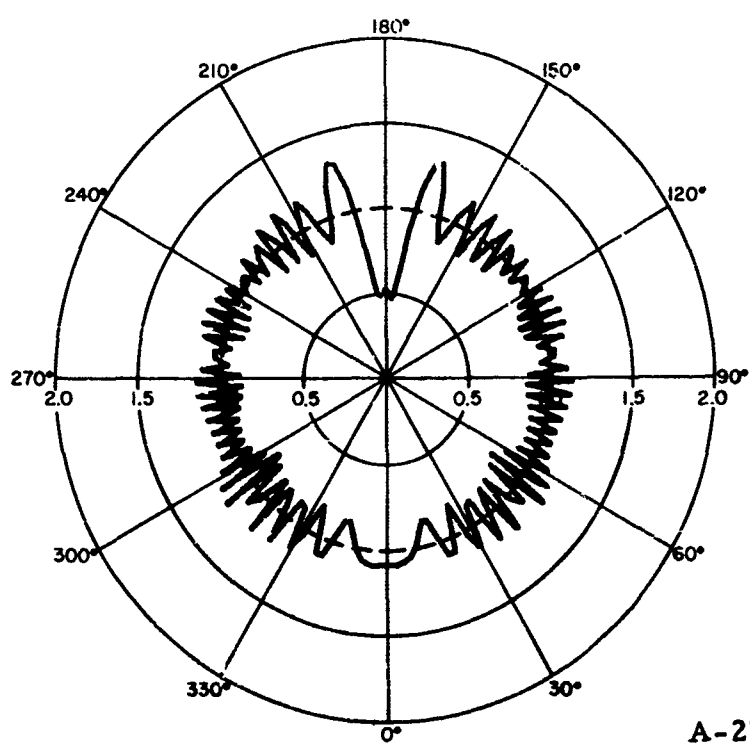
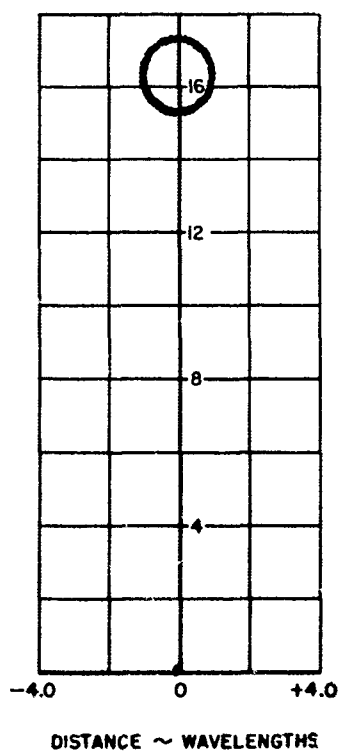


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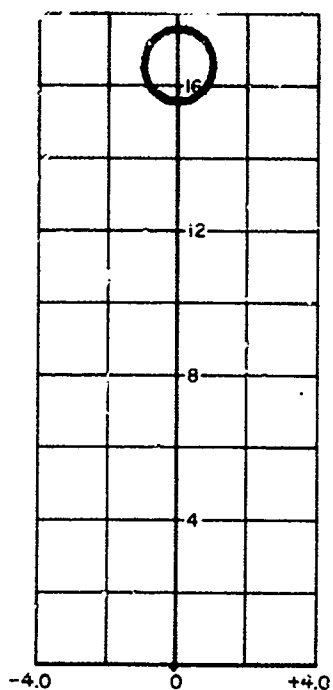




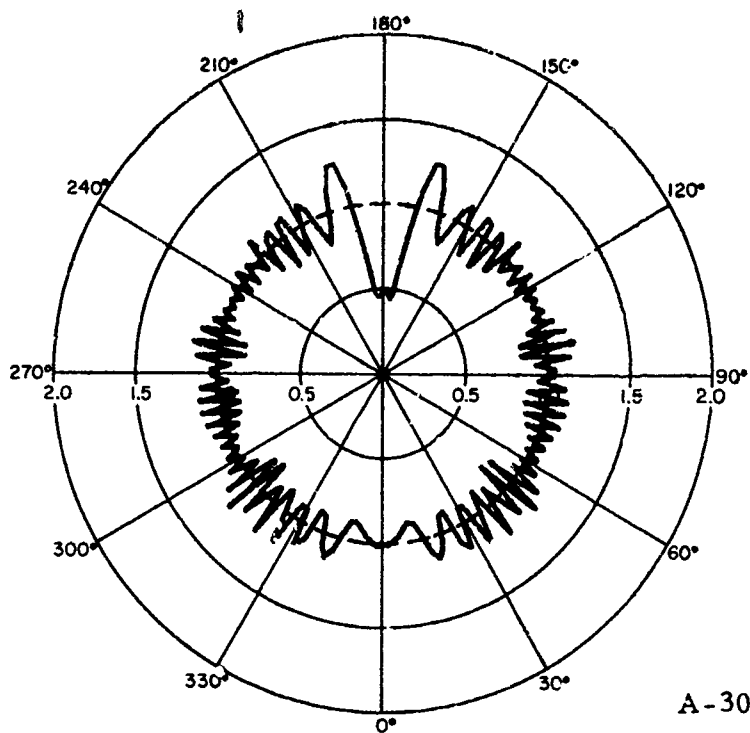
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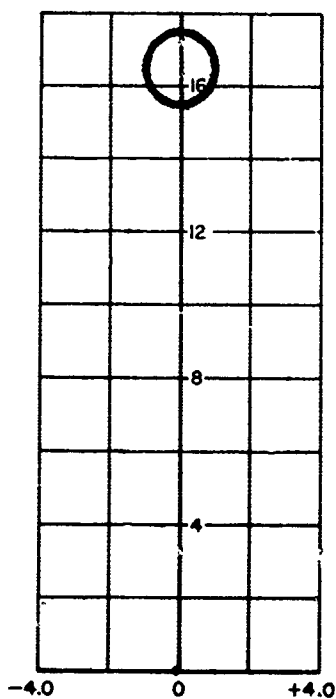
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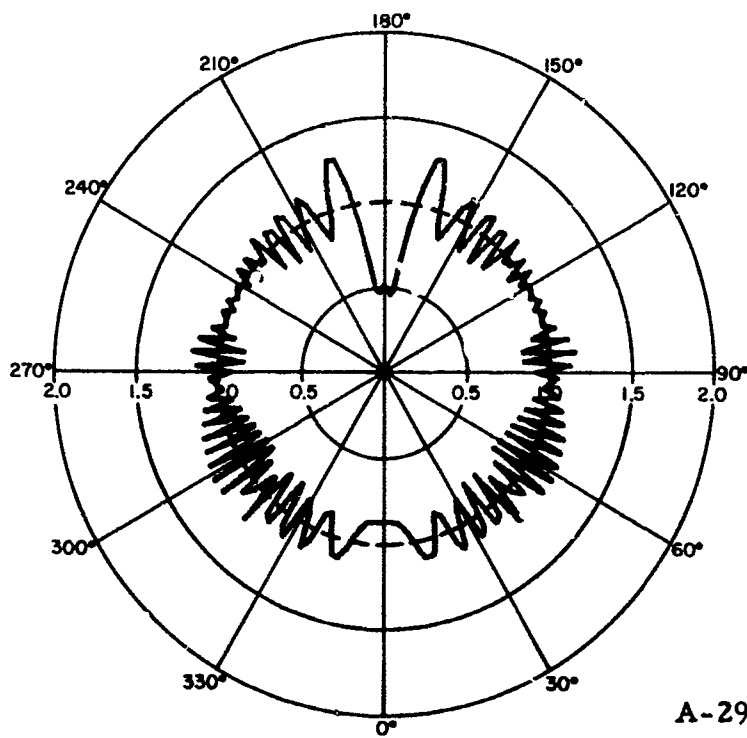
DISTANCE ~ WAVELENGTHS



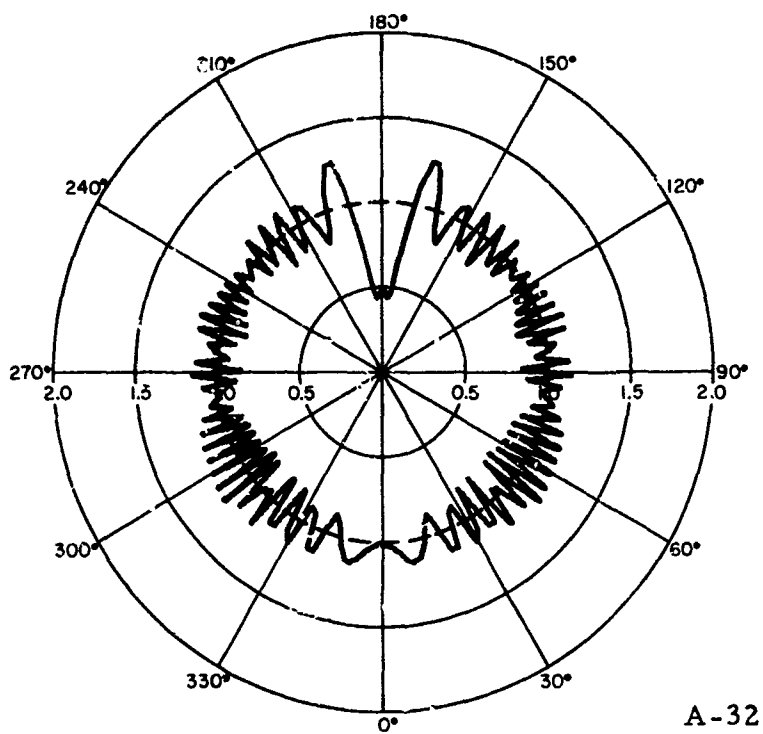
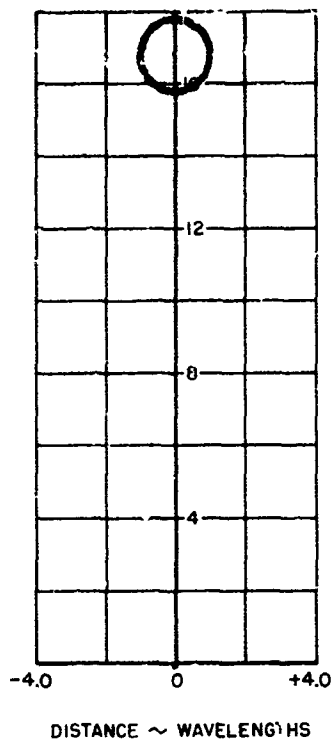
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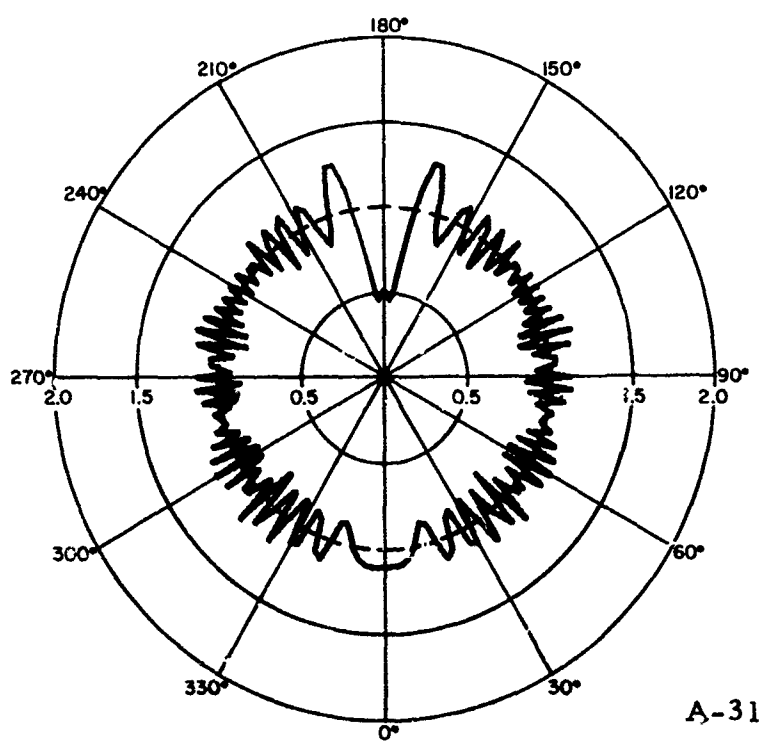
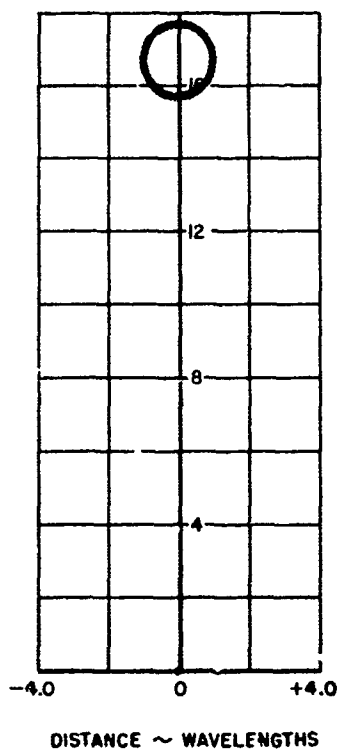
DISTANCE ~ WAVELENGTHS



A-29



A-32



A-31

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1. Richmond, Jack H., "Scattering by an Arbitrary Array of Parallel Wires," Report 1522-7, 30 April 1964, Antenna Laboratory, The Ohio State University Research Foundation; prepared under Contract Number N123(953)-31663A, United States Navy Electronics Laboratory, San Diego, California. (AD 443 833).
2. Thiele, Gary A., "Far-Field Pattern Prediction for Shipboard Antennas," Report 1522-11, 31 March 1965, Antenna Laboratory, The Ohio State University Research Foundation; prepared under Contract Number N123(953)-31663A, United States Navy Electronics Laboratory, San Diego, California. (Vol. I of this handbook.)
3. Thiele, Gary A., "Memorandum on Shipboard Antenna Far-Field Pattern Prediction," Report 1522-12, 1 July 1965, Antenna Laboratory, The Ohio State University Research Foundation; prepared under Contract Number N123(953)-31663A, United States Navy Electronics Laboratory, San Diego, California. (Vol. II of this handbook).